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The Weston Exhibit at the Electrical Exhibition

Our illustration is a very faithful one of Mr. Weston's remarkable exhibit, even though the crowd of people which gathers around it, attracted by its variety and novelty, is left out of the view, so that our readers may be able to appreciate it.

This is Mr. Weston's personal exhibit, separate and distinct from that of the United States Electric Lighting Co. It is, in one of its parts, essentially a laboratory exhibit, while the other part is intended to illustrate somewhat the electrical transmission of energy and its utilization as mechanical power.

Under the show-cases toward the observer, and fronting on the main aisle of the building, are large framed photographs of the interior of the works at Newark, N. J., of the United States Electric Lighting Co., the makers of Mr. Weston's machines. The show cases in front of the gentleman, lady and boy, contain various of the fittings for incandescence lamps, in a dissected state, so that the several parts may be seen as they are before being assembled. Back of these cases is, first, a table containing various test instruments used for laboratory work, such as test, astatic, tangent, and other galvanometers, of high and low resistance, for use in determining differences in potential and strengths of current; a novel magnetic-field explorer; Weston-Clark standard cells, condensers, etc., etc.

The rectangular frame is a rheostat consisting of ribbons of German silver, and variable, by means of a slide on the top bar, between a fraction of an ohm and ten ohms. Other forms of rheostats, variable and otherwise, but of large size, are also shown.

On the triangular frame at the end of the booth are dissected armature-cores, showing the construction of the Weston armature. Beneath it, on a table, are the various sizes of collectors, or commutators, and their separated parts. In show cases, at the back of the booth, are specimens of all the materials used in the manufacture of incandescence lamps in the various stages of the processes. Here are several forms of mercury pumps used in exhausting the globes, and the accessory fittings therefor.

In the centre of this part of the space is a laboratory test-table, with many instruments of Mr. Weston's own invention or design thereon. A method which he has designed for testing the capacity of condensers is specially noticeable. The tall structure hung with curtains is a photometer used for light determinations in incandescence. In this space there are models of various machines and apparatus made by Mr. Weston.

The waterfall in the centre is produced by the use of an Andrews centrifugal pump, raising 600 gallons of water per minute, when run by a Weston dynamo, for the nonce used as an electric motor. This waterfall is a very pretty feature, and especially so when it is lighted by numerous incandescence lamps placed tastefully about the rocks and foliage, and in large water-globes, in which swim gold fishes.

Beyond the water fall is a machine shop containing lathes, planers, drill-press, etc., driven by an electric motor of the same pattern as that which actuates the machinery of the water fall. Along the front are more photographs to match the others on the front of the first-described half. In the show cases are specimens of the materials and products of the various stages of the process of manufacturing carbons for arc-lamps. In one of the cases are samples of anodes, nickel salts, and solutions made under one of Mr. Weston's patents; nickel plated goods and the like.

In our issue of the 13th inst. we gave several illustrations of Mr. Weston's new incandescence lamp, which constitutes one of the notable features of the exhibit, and whose rich, mellow light aids in beautifying many parts of the Exhibition. These lamps are exhibited in profusion by the United States Co., and may fitly be referred to at the present time. They show what can be done with incandescence lighting on the grand scale, in a field to which it has been supposed only the arc light was adequate. Mr. Weston's new departure is one whose importance is, perhaps, hardly yet realized as being the means of causing a revolution in some departments of the electric lighting business. The filament of these large incandescence lamps, some of which reach easily 125 candle power, is made of a material prepared from cellulose by a new process. It is exceedingly strong and evidently capable of sustaining very high temperatures for a long time. The zig-zag shape of the filament in the lamp equalizes the distribution of the light in all directions, and the ground-glass globes used in some instances by Mr. Weston are admirably adapted to soften but not dim the radiance. The construction of the lamp we have fully described.

There are numerous specimens of electrotype work in the production of works of art, copies from nature, etc., by electro-deposition of copper by Weston's plating machines in the hands of Mr. Hollingshead, the well-known electrotyper.

The exhibit, taken as a whole, is a remarkable evidence of the call that electrical development has made upon the most varied branches of industry for new applications and devices. An impetus and a stimulus have been given all along the line, from the powerful, high-speed steam engine to the daintiest bit of brass-work or fancy wood molding for the lamp in study or boudoir.

An enumeration of the articles under the cover of this double booth would take too much space. We expect in future numbers to deal with them in detail. They are all of interest to the electrician and to those in any way concerned in electric lighting. It reflects great credit upon Mr. Weston, whether in the light of his inventive talent, or that of his liberality in exhibiting so much which many would keep secret.

Mr. Weston has himself taken an active part in the arrangement of the exhibit, and has been very courteous in explaining the uses of his apparatus to inquiring visitors, of whom there are not a few.

A VIEW OF THE WESTON EXHIBIT AT THE ELECTRICAL EXHIBITION, PHILADELPHIA.

National Conference of Electricians.

FOURTH DAY, SEPT. 12, 1884.

The Conference met pursuant to adjournment.

The President: Reports of committees are now in order. I will call upon the committee which was appointed to consider the subject of the watt, if it has any report to make. Prof. John Trowbridge is chairman of that committee.

Professor Trowbridge: It is a surprise to me that I am on a committee on the subject of the watt, and, therefore, I shall call upon Prof. Preece to give us his views upon this subject, as I understand that he has prepared a short and informal statement in regard to the adoption of the watt.

Mr. W. H. Preece: Mr. President, I regret that other duties at Montreal and the heat of the weather have prevented my writing down properly what I should have liked to have said respecting the adoption of the watt as a unit of power. Now that it has been virtually decided that all electrical measurements shall be given in the terms of the C. G. S. system, it seems essential that all our units—units of work and units of power—should also be connected with this system, so that we shall avoid the use of any co-efficients whatever.

Of all the units that have been introduced, there really is not a single one more important than that which records the rate of doing work—work of electrical currents or the work of moving a tram-car or any mechanical work. These are all precisely of the same kind. It is quite possible to express the work done in an oil lamp, a gas lamp, or an arc lamp, in exactly the same terms, and, by way of parenthesis, I might just mention that a more careful calculation of the work done in different systems of artificial illumination shows that while the simple sperm candle that is taken as the British standard of light consumes 97 watts for each candle, the gas lamp such as we use in London, burning 5 cubic feet per hour, giving, I think, 14 candles, consumes 62 watts per candle.

So that we have here a ratio of the rate of doing work between two systems of illumination, one by the sperm candle, which consumes 97 watts, and the other by the gas lamp, which consumes 62 watts. But when we come to electric lighting, we find that a good incandescent light gives out its illumination at the rate of 2.5 watts per candle. So you see how easy it is to express in terms of this watt the ratio of the energy expended in different modes of artificial illumination, and to see how we can economize, and what a question of vast importance the subject of electric lighting is.

What is a watt? A watt is the rate at which work is done, when an ampère is maintained in an ohm. When we maintain through an ohm an ampère current, we are doing work at the rate of 1 watt per second.

This unit was proposed by Sir William Siemens two years ago, and it became such a necessity that it was instantly adopted by all practical electricians in England.

It has been used to a very large extent by practical electricians here. This unit was previously expressed as the volt-ampère; but, being a subject of such vast importance, it only wants the authority of this Commission to add it to the list of units already accepted.

It has been accepted by the British Association at Montreal, where I brought before them the same proposition, and with the assistance of the British Association and this Commission, I have not the slightest doubt that the term "Watt" will be introduced all over the world. I tried to bring this before the Paris Conference last year, and the reason why it was not accepted was twofold: First, the Germans objected to the introduction of any more English names; and Secondly, the French objected to it because they have no W in the French language. These two objections do not apply to us. Watt was an American as much as an Englishman, and we should be proud to apply his name to the unit which is connected with his measure of foot-pounds.

This brings me to a second proposition. A unit of power was originally determined by Watt himself. In order to express the value of the different engines he produced, by a series of very careful experiments he measured the work done in a given time by a large number of horses, and the average amount of work from an average horse turned out to be 22,000 foot-pounds raised per minute. Somehow or other, Watt thought that 22,000 foot-pounds per minute was rather a small unit, so he added 50 per cent to that, and called that his "horse-power," making 33,000 foot pounds per minute, or 550 foot-pounds per second as the horse-power of mechanical engineers.

But that has nothing to do with us. We want a large unit for power; the watt is small. The watt is excessively valuable for electrical measurement. It is too small for mechanical measurement. If we were to adopt the decimal system of measurement we might call a thousand watts a kilo-watt. But there is no reason why horse-power should not be retained, and my proposition is (it is a proposition which is received with a great deal of favor by some of our mechanical engineers on the other side) that the horse-power itself should be altered. It is now 746 watts, but if we increase that by 34 per cent.; that is, if we raise that horse-power from 33,000 foot-pounds per minute to 44,220 foot-pounds per minute, we shall obtain a horse-power which shall be exactly a thousand watts, and shall have a unit that shall connect all physical measurements with mechanical measurements, with no coefficients introduced, and we shall have more sensible units than we have had.

So, sir, the proposition that I had intended to write down for your acceptance was that the unit of power shall in future be the watt, and that the horse-power shall be raised 34 per cent., in order that it may be a thousand times this unit of power which we call watt.

Prof. Newcomb: I would like to ask a question with regard to the watt as defined by the electricians, in whose company I am not to be counted. It is defined purely electrically. I would like to ask if that corresponds to the C. G. S system. How many ergs per second is it?

Prof. Brice: It is ten to the 7th power per second. The real unit of work in the C. G. S. system is an Erg per second, but that is too small, and it has been raised to the 7th power which gives the watt.

Prof. Newcomb: I would rather see the mechanical than the electrical definition adopted, although they amount to the same thing, and it would be better to take the 6th power of ten rather than the 7th power in our whole system of units. I make that suggestion to the members of the committee.

Mr. Cross: It seems to me that we might follow out Mr. Preece's suggestion and call a thousand watts a kilo-watt or we might multiply the watt by a thousand and call it a horse-power if there were no confusion with the French "force de cheval" and the English horse-power as so used.

Upon the question of a standard for light Mr. Preece said: This question of a proper standard for light is one that has occupied our attention in England now for some two or three years, and there exists a Committee on Standards of Light which has existed now for two years, but which has not done much work. Prof. Geo. Forbes, who is here, is a member of that committee, and during the next four months we shall undertake to make considerable experiments on this subject in England, and I trust that this meeting will form a permanent committee on this subject, so that simultaneously with our work in England experiments may be carried on on this side of the water.

There are two points involved in this subject. The first, a practical one, the establishment of some standard of light that we can all understand, that we can all work by and reproduce in our own laboratories at any time; and there is another and more difficult one of a standard of white light. The two things are quite different. You want a practical standard of light to enable you to carry out your measurements in terms of something you know is absolute. You want also to have a definition of white light so as to be able to express the efficiency and the value of different characters of light in terms of something that shall collect all the lights together by some such system as we have been discussing.

We propose during the next twelve months to put aside this question of white light and examine all the practical standards that can be found in the market that are in use.

We also are going to test the value of the human eye to measure and compare these different lights. There is unquestionably a personal equation connected with this measurement of light. It has never been thoroughly gone into on our side of the water, and I do not think it has been on this. One of our first acts when we go back to London will be to organize a system of measuring the efficiency of the human eye for the determination of the value of light. At the present moment there are three or four real standards.

In England we have the British Standard—the candle that has been defined by act of Parliament. It is a particular kind of sperm candle that burns 120 grains every hour, and it has to possess a certain height. Then we have in Germany another candle, different in value from this English candle. In France we have the Carcel lamp, burning a certain quantity of oil at a certain rate per hour, and giving a flame of a certain height. The value of the French standard is actually 9.7, that of the British candle. Then we have another standard that has not been accepted at present by anybody but myself. It has been accepted by myself, because I produced it. This is another standard altogether.

It is not a standard of light, it is a standard of illumination. I want to know the illumination of this surface of white paper. (Indicating) I lay it on the table here, or I lay it on the floor, or anywhere, and I want to know what the illumination of its surface is, taking sunlight or moonlight, taking gaslight or candle-light, or the electric light. What I want to do is, to establish some standard that will enable us to measure the illumination of a surface. For instance, I take a street that is lighted by gas, and the street that is lighted by an incandescent lamp, and I want to know the illumination of the surface of the street in different places. You want to know the illumination of your shop-front, or the sides of your house. You want to have some mode of expressing that thing in order to understand the intensity of light quite independently of the source of the light. The standard I have proposed is the light upon such a surface as the white paper when the light is emitted from a British candle at 12.7 inches. I have made it 12.7 inches because that corresponds with the light emitted by a French Carcel lamp at a distance of a metre.

The French are so jealous of everything English that we could not give them a standard metre that they would accept, but if we were to give them a standard based on that principle without a British inch, I think they would use it. Therefore I have proposed that this should be a standard of illumination and not a standard of light.

There are a few questions we shall discuss through this committee in England. The first is the most practicable standard of light; 2d, the practical standard of illumination, and 3d, the most practical mode of measuring photometrically these two. The British standard candle is an admirable theoretical standard for expressing the numerical value of light, but we find the incandescent lamp is by far the most convenient instrument to compare lights by.

It is not a very difficult thing to determine the light emitted by an incandescent lamp with a given current, and you can produce that light when you know your current at any time within months and months after the experiment.

If you have an incandescent lamp which you only use for measuring light you can maintain that lamp constant for any number of months. Prof. Abney and myself have worked very hard on this question, and we find an incandescent lamp is a very handy and convenient instrument for measuring other lights, and you can express this light in terms of the British candle so as to bring in the unit.

I shall not be able to take part in the consideration of this matter. I do not think we should be hasty. I think it will take months to inquire into this matter. However, before I leave for England, which will be in the middle of October, I will put in writing all my views and submit them to the committee for their consideration.

I might add just one word more. Another object that we have in view is that by using an incandescent lamp whose light depends simply upon the work expended in the given filament, and whose light, therefore, can be expressed in terms of the watt, we have by taking an equal filament as our measure, expressed this light in terms of the candle, so that we have a direct connection between the measurements of the light and the measurement of the candle power, and through the watt we come at once to the measurement of light in the C. G. S. system of absolute units.

Mr. Kovle: There have been some experiments made upon the subject, and it has been decided by those who know most that among standards of light depending upon the light produced, the current of electricity through a metal of high resistance is the best we know. Would it not be better to use instead of an incandescent lamp, which is now composed of a long filament of carbon some three inches in length, something like platinum, having a square surface. The light emitted by surface of platinum of half a centimetre or a centimetre of definite resistance under a given current would be constant. We would then measure at right angles to the illuminated surface and have a much more constant standard of light than with the carbon filament which we measure at right angles to the curve of the carbon filament.

Prof. Cross: I would like to say that there appears no necessity to use carbon light as a primary standard. As a primary standard you can have the carbon filament mad of a length which is definite; but as a secondary standard I can see that it would be one of the best standards that we can have. I do not understand whether Mr. Preece intends to use the incandescent light as a primary or as a secondary standard.

Mr. Preece: At present we only contemplate using the incandescent light as a secondary source or standard. With regard to the use of a platinum point, that was proposed by Prof. Henry Draper. It was found that platinum was most unreliable under those circumstances. There was a constant disintegration at the surface, and the light varied a great deal. I do not think any experiments with the platinum wire are valuable.

Prof. Cross: It seems to me that we ought not to attempt to go too far, that is to connect the sensation of light, which is of course all we mean when we say "light," with the C. G. S. system. All we know is that in a lamp so arranged we have a definite amount of energy that affects the eye. Light proper is a sensation, and of course we cannot hope to connect that with the C. G. S. system.

The President: I will now proceed with the discussion of "The Theory of the Dynamo Electric Machine." I have prepared here a skeleton of the theory of the dynamo machines. I don't claim for it perfection. I only claim to give a few points in the theory of the dynamo machine which may be of interest and possibly of value to those who are constructing these machines. Mr. Fitzgerald was to second me in this discussion and give some important points on the subject, and the discussion will be more or less imperfect unless he arrives.

The principal losses of the machine are put down under these heads:

1st. Mechanical friction.
2d. Foucault currents in the armature.
3d. Energy arrested in magnetizing the magnets.
4th. Self-induction of the currents.

These are the number of losses which I, at least, intend to discuss.

Of course the efficiency of the machines would then be equal to the whole work of the machine minus the different losses divided by w, namely $E=\frac{w-l_1-l_2}{w}$.

Thus when these losses are obtained, the efficiency of the machine is known.

The mechanical friction I shall not discuss.

With respect to the loss from Foucault currents in the armature, by dividing up the armature in the proper way we can get rid of most of these Foucault currents. It is a method very often effected in the Siemens' armature by dividing up the armature into discs. The greater portion of the currents are got rid of in that way.

I have purposely omitted the loss due to the change of magnetism of the armature. As the armature revolves in one of these machines the iron changes in magnetism. It has been recently experimented upon and been found that although there is some small heating effect, yet it is very small indeed. I drew attention to this fact several years ago and experiments have been made upon this very subject by makers of the dynamo machines, and Edison, for instance, has evolved a dynamo made up in this manner so that the Foucault currents do not exist, so that practically this loss amounts to nothing. I think that that question has been discussed enough and I shall therefore take up the third loss, which is in the current or rather in the energy used in sustaining the magnet.

If the magnet were of steel there would of course be no loss due to this third cause, and the only reason for not using a steel magnet is that they cannot get sufficient field; the field is moderately weak. I cannot give you the ratio, but I suppose it is at least one-third of that due to an electro-magnet. Perhaps this point may be brought up in the discussion, and somebody can give us the results. But so far as I know now the field from a permanent magnet is generally less than one-third of that from a good electro-magnet. It could not be made equal to it by any possible means. Therefore in most dynamo machines that are used on a large scale the magnet is produced by the current.

It is a question what the form of a magnet and the position of these coils should be in order to get the greatest field with the least expenditure of energy. I have one or two propositions to make on this subject which I think are, I won't say of vital importance to makers of machines, but, of some interest.

The first proposition I have to make is that a round magnet is better than one of an elongated cross section. Those who have used the old Siemens machine will recollect that the magnets, there were formed on a system of bars around which the wire was placed. If the coils are long (I do not know that it is necessary to assume that they are long if they are long enough for the purpose, and the coils are generally long enough—the theory assumes an infinite length of wire) the magnetic force at any time acting on a round iron core is exactly the same as on an elongated core; but the area of a circular section is much greater than that of an elongated section for the same circumference, and therefore the same amount of wire which would be used to go around the elongated magnet could be extended further on a circular section, and would obtain very much more work. Some people say that the principal object of making an elongated magnet is that it may include the whole length of the armature. Suppose we were constructing a dynamo machine with a very elongated magnet, we have to elongate it here (Fig. 1) and make a pole-piece in which the armature might revolve. Most makers who adopt this form think that it is better to elongate this (A, Fig. 2) out in these directions (arrows, Fig. 2). But we have seen that the round form is more efficient in general than the elongated form, and the only question is whether it will be more efficient in this particular case. I shall proceed on this theory upon the known fact that you can consider lines of force as if they were conducted by the iron and the air outside. The conductivity of the iron for the lines of force is very great—much greater than that of air. I experimented on it many years ago, and my idea is that the greatest value of the conductivity was something like five thousand times that of air. It depends upon the magnetic force, and of course it is a variable quantity.

I think it varies from several hundred up to five thousand times that of air. The conductivity is very great, especially of wrought iron; for cast iron it is probably less.

Therefore the lines of force will be conducted from any point over a circular cross section very nearly as easily as they are over an elongated cross section, and the saving in the wire will be considerable.

I have another proposition to make with respect to the magnet, and that is that one circuit of the lines of force is better than a number. Some makers might connect the pole pieces of the armature to a number of electro-magnets, and even if they were round there is loss from having a number. For this reason, that the same amount of wire produces the same magnetic force in each of these coil pieces provided there is the same number of

FIG. 1.

wires per unit of length; and that same amount of wire might be made to go nine times around the iron instead of three times. Therefore you would get inside your magnet three times as much iron as you would do, and yet have the same magnetizing force going on the magnet. The proposition is that one circuit is better than two, and that not only applies to this form of magnet (Fig. 3), but it also applies to the form where we have the armature revolving between two magnets like this (Fig. 4). Because if we should turn this section around (*a*, Fig. 4), and bring the two together, and we would have two sections. The circuit of the lines of force is around in this direction and in this (arrows, Fig. 4). So that there are two circuits of the lines of force instead of one. The working energy expended with a given amount of work will be less with this form (Fig. 3) than in the form where you have two circuits like that (Fig. 4); that is of very great value to makers of machines.

I had a number of drawings made simply of magnets in the Electrical Exhibition, and I find very great difference in this respect. There is more difference in this respect where Siemens armatures are used than in any other kind of armatures. In discussing these drawings I do not give any names nor say whether any one machine is better or worse than another; but I merely discuss the aspects of the case, and illustrate by some machines which are found in the Electrical Exhibition.

First, I will discuss in general the forms of the magnet, and I wish to say something in respect to the form of the poles that inclose the armature. Of course these forms belong both to the Gramme ring and the Siemens armature, and you may consider them both one if you wish. This magnet (Fig. 2) belongs to both of these forms and

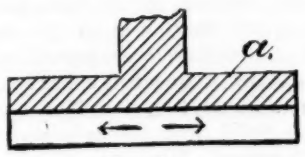

FIG. 2.

almost any form. I may mention once more, that of course that theorem with regard to the number of magnets applies to a number of those old machines where there was a very large number of little magnets revolving around other little magnets. More work is used in sustaining the magnets in that form of machine than in the more modern form where we have only a few circuits. We will now proceed with respect to the field in this (Fig. 5).

The lines of force proceed down the magnet and are supposed to go across here (*a* to *b*, Fig. 5). Wires are wound around the armature and revolve around across the lines of force, and so produce a current. It is evident that any lines which escape across this part (arrows, Fig. 5) are lost. If there was any leakage of the wire around the magnet, that would be lost. In case the wires touch there would not be much loss, but if there was a leakage in the wire the current, instead of going around the magnet, would go off somewhere else, and we should consider the machine defective because there was a loss of the current. If these lines of force, instead of going across there (*a* to *b*), go across here (arrows), as they naturally would

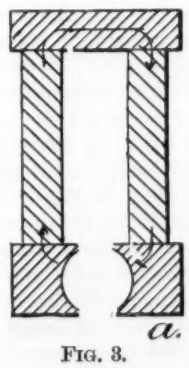

FIG. 3.

do, all those lines of force are lost, and we would have to add so much more current in order to make up for this outside loss. I have an illustration of this from the drawing which I will give you (Fig. 6).

This machine has two magnets, one above and one below. The lines of force pass up there (*a*) and then out through here (*b*) and then up through there (*c*). These outside pieces (*d*) instead of being far off, are down close. Here is one pole of the magnet near this piece. The lines of force instead of passing across the field of force as they ought to do, pass off here (arrows). The circuit cannot go around, for it would go down and across this opening and up that way (arrows). In this case there is loss, due to the lines of force leaking out; and if these pieces are too near, the lines of force will pass across that opening instead of passing across the opening where the wires revolve; so that there will be a loss, and we shall have to enlarge our magnet, and therefore have more energy expended in keeping up the magnet. There is energy expended in keeping up the field outside as well as in keeping up the field of the magnet. So with respect to this machine it is important that this point should be considered. In this form of a machine (Fig. 3) where there is a small circuit, this magnet has to be attached somewhere. They usually put on a piece of brass across the poles to attach it to. Very often this magnet is turned vertically in the way shown, and then the whole thing is attached to a cast-iron bench. I have no doubt that considerable lines of force are lost in passing across this magnet to this iron piece. I do not think much is lost at that point, but some is lost. The makers of the machine, I suppose, considered this to some extent, but what is needed is measurement on that point.

How many lines of force go across the armature opening and are effective in producing the current, and how many escape and are lost?

These questions are just as important as the question of the leakage of the current in the wire.

There are defects in many of these machines in that respect. By the way, in this last form, some people may say the putting this here and here (indicating *d d*), adds to the strength of the magnet. It does undoubtedly add to the strength of the magnet, but those are useless lines of force that pass across here (arrows). If you measure it here the

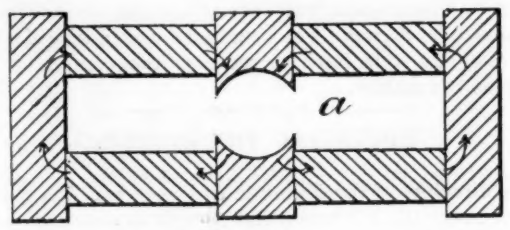

FIG. 4.

strength is increased, but you do not increase the strength when you take into consideration the loss.

Here is another form of magnet, Fig. 7. That machine would be defective. It has two magnets in the place of one, and it has two magnetic circuits in the place of one; and many of the lines of force probably make little private circuits of their own around in that way (arrows). Those lines of force are of course lost, and therefore it is more or less defective in that respect. There are machines which this figure represents exactly, but it is not meant for any particular machine, it is meant for a scientific drawing.

A Member: I should like to ask where are the cores of the field magnet in that figure, for I happen to be connected with a machine which that represents very closely.

The President: No names of machines are to be mentioned in this discussion; we have nothing to do with it. As I understand it, the cores are to be put like that (*a a*, Fig. 7). There would be a little more opening perhaps than I have drawn to the four corners.

The Member: Thank you, that satisfies me.

The President: I am only giving a general idea of the principles of these machines, and I do not refer to any particular machine. It is also important that this line of magnetic induction shall find easy passage around in order to produce the most intense field. Suppose this was the pole (*c*) then the opening at the sides must be made as wide

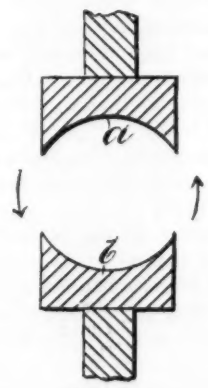

FIG. 5.

as possible; everybody recognizes that! The reason for that is, in order that the lines of force may find easy passage across this opening (*c* to *c*).

Suppose we had a machine made in the following manner (Fig. 8.) I don't want to say that it is anybody's machine; I may not have made the drawing right; but suppose there was such a machine, and that somebody did make it, in which there was a magnet with a Gramme ring here (*a*) pole-piece here (*b*), one ring here (*c*), and pole-piece here (*d*), but not any on the other side. How are the lines of force to pass? I do not know that it would be easy to see how; there is no easy passage. They evidently go around here (arrow) and strike into the Gramme ring, and I suppose pass across the opening here (arrow), and go to the other side the best way they can. You see there is no easy passage around for the lines of force in this case.

Member: May they not to some extent follow the shaft?

The President: It may be possible for them, perhaps, to go down and around, but it is evident that if the shaft is made large enough, they come together around in that way, from *d* by shaft to *b*, but it is not so easy for them as to go across.

I have here a formula for the amount of work which one has to put upon a magnet to produce a certain effect. I will take the case which I have considered most efficient, where there is one magnetic circuit. Here you will have the lines of force going around this machine in this manner (arrows of Fig. 3). The reason they go around is from what I have sometimes called a magneto-motor force. It is not a very bad term to be used. It is an original idea of Faraday that these lines of force are conducted by a metal. We suppose these lines of force pass around this (arrows), and then they have to pass through the iron and across the opening in this way (indicating), and they are caused to do that by what may be called the magneto-motor force of the helix. The magneto-motor force of that helix is proportional to the number of coils around the magnet and proportional to the current *C* in the wire. I won't write down the exact expression for this quantity; I will

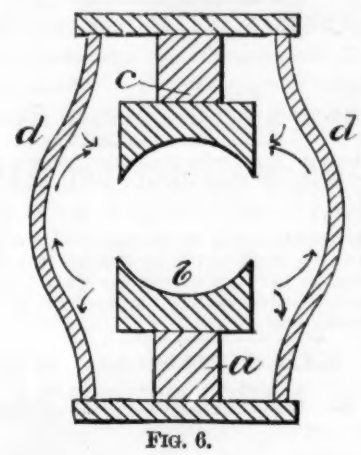

FIG. 6.

only say the magneto-motor force is proportional to *N*, the number of turns around the magnet, and *C*, the current. The number of lines of force which pass around here we may call *B*. This is not the quantity which Maxwell considers, but it includes the whole number of lines of force which pass through the magnet. We may write *B* proportional to *N* the number of turns of the wire, and *C* the current; and inversely proportional to the resistance of these lines of force in going around this circuit. The resistance of the lines of force is proportioned to *L*, the length of the iron of the system, divided by *S*, the surface cross-section of the magnet, supposing it to be a uniform surface, into π, the magnetic permeability of the iron (or you may call it the conductivity of the iron for the lines of force.) This quantity π varies with the current, it can readily be obtained; indeed, some years ago, I gave a formula for it. It can be expressed simply as dependent upon the magnetism of the iron and a constant depending upon the iron alone. Then to this, we have something more to add.

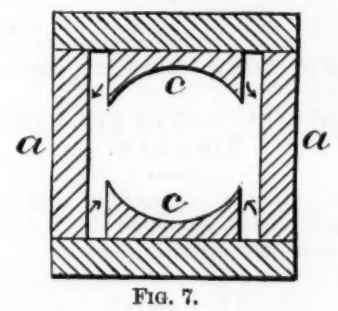

FIG. 7.

Let 1 be the width of this opening (indicating) and *A* the area across which the line of force flows; then we have to add $l \div A$., we have still to add to this a certain quantity which we can call *p*, which depends upon the resistance of these lines of force which escape in all directions. It represents loss due to the escaping of the lines of force. Thus we have the final value for the magneto-motor force,

$$\frac{N.\ C}{\frac{L}{S\pi}+\frac{l}{A}+p}$$

This gives us an equation which may be solved with respect to π.

It is evident that the curve for the magnetic permeability is of this nature.

It rises to a maximum here and then decreases. It will not rise as much as this diagram (Fig. 9) indicates, but it will be a more flat form, according to the value of 1 and *p*. Therefore, increasing the magnetic force on your magnet, a certain point will be arrived at where it becomes very easy to magnetize a magnet, and after that it becomes harder and harder to magnetize the magnet. So that in practice you should get the form of this curve, so that it should produce a very strong magnetic field. This can only be done by an exact calculation, or better by experiments on the machines, examining at each point the forces of the current, and in that way getting an idea of how these lines of force go, and we can then see whether this area is large enough to take all the lines of force necessary to pass around. The mathematical investigation is a long one, and I cannot take it up here.

I have here an expression for the work necessary to keep up a proper field in the magnet. Of course as you coil the wire on these magnets, the coil becomes thicker and thicker, and in order to have a sufficient magnetic force across this opening with sufficient velocity you must have sufficient wire. As you increase the thickness, of course

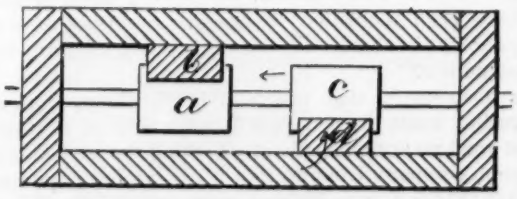

FIG. 8.

you have to use more wire for a certain core. Every core acts very nearly the same as every other in producing force; therefore, if you have the magnets very short indeed, you have to pile up your wire to a very great extent. The wire is made of copper, and as iron is cheaper than copper, it might be better to lengthen out the core slightly. I don't know where the lengthening should end; but I should suppose you would lengthen out the core until the given length of wire on the magnet may make a moderately thin layer. Of course, as you lengthen out your magnet the resistance of this circuit to magnetization becomes greater; but that is a very small quantity; I do not sup-

(*Continued on page* 114.)

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ANOTHER CONSTRUCTION OF THE UNDERGROUND WIRE LAW.

A high legal authority in Brooklyn recently expressed in a formal and official document his opinion that the underground wire law was not intended to present any legal obstacle to the rebuilding and extension of aerial systems. The view of Corporation Counsel Taylor was that the law only declared the policy of the State in regard to future plants. Now, however, an opinion of very different character has been given in Supreme Court Chambers, by Judge Van Brunt, in continuing in force the injunction restraining the Baltimore & Ohio Telegraph Company from erecting a pole in front of the premises of H. Clausen & Sons, in Second avenue, between Forty-seventh and Forty-eighth streets. According to him, the courts are more and more disinclined to hold that the owners of land abutting on the streets have no rights that are to be respected by other parties. Thus, he says: "It is urged in the case at the bar that the telegraph pole does no injury whatever to the land of the plaintiff in that it does not obstruct the light, air or access to any portion of the building now erected on it. This is no answer to the present application. The abutting owner has an absolute interest and right to the light, air and access to his premises arising from the opening of the street upon which his premises abut, and which he has bought and paid for, and no person has the right to interfere with such light, air or access not simply in respect to the building which may be now upon the premises, or in respect to the use to which the premises may now be applied, but in respect to any building which such abutting owner may see fit in the future to erect upon said premises, or in respect to any use to which he may apply them. If, therefore, the pole in question would interfere with or obstruct the light, air or access to any building which the abutting owner might erect, or render more difficult the access to the premises under any use to which they might be applied, such owner is entitled to claim that the pole shall not be erected until proceedings have been instituted to acquire the right so to do. The question is, therefore, Does this pole constitute such an obstruction?"

His decision is that the pole is an obstruction, and he brushes aside the plea that because Second avenue is a post road no authority short of Congress can stop the telegraph company from putting up wires and poles there, as "the theory carries Federal authority far beyond any point which the most confirmed believer in centralization has yet had the hardihood to claim."

But not content with discussing general principles, Judge Van Brunt goes on to deal with the argument that the Daly act does not affect lines above ground prior to the date of limitation, November 1st, 1885. He and Mr. Taylor do not agree in their views on the subject by any means. His interpretation and construction is as follows: "The Legislature intended that large cities should be freed from the nuisance of having their streets incumbered and disfigured by numerous poles crowded with wires and cables, and it therefore provided that 'hereafter'—viz., from and after the passage of the act—'all telegraph, etc., wires should be placed under the surface of the streets.' In other words, from and after this date no new construction of telegraph lines shall be permitted above the surface. In the second section of the act they give until Nov. 1, 1885, for the owners of wires already constructed above the surface to remove them and place them underground. If it was not supposed that this act had some office to fill at once, why was the fifth section added, which reads as follows: 'This act shall take effect immediately?' There seems to be no way of applying the provisions of the fifth section if the first section does not go into effect until Nov. 1, 1885. Therefore, considering the evident intention of the Legislature, and the evils which they sought to remedy, but one construction can be placed upon the language of the act, which is that no wires should be put above the surface of the street after the act became a law, and that all wires then existing should be removed prior to Nov. 1, 1885." The only exception he makes is in behalf of the city departments, as the city can put the streets to any use it chooses, for the efficient discharge of police duties.

How far this latest decision will affect the various companies to whom aerial wires are still essentially necessary, remains to be shown. The situation is not a very satisfactory one, but it is hard to see how the companies can move in the matter.

EDUCATING THE PEOPLE.

The directors of the Franklin Institute are doing their best to make the Electrical Exhibition, as much as possible, an educational institution. The thousands of people who flock to the place are not allowed to go away wondering and puzzled for lack of explanation, but are offered instruction at every turn in an easy and simple form. Electrical primers have now been prepared describing in plain language the leading features and the important principles of electrical applications, and abstracts of the primers, in bold type, encounter the eye everywhere. The primers can be had for a mere trifle, so that when the people go home they can refresh their memories and describe intelligently what they have seen.

As we have been long engaged ourselves in the diffusion of electrical information, we heartily welcome these efforts. They are rightly directed and must result in great good. Theoretical electricity and practical electricity need to be "understanded of the people," and the interests of the science will be advanced by fuller knowledge among all classes. The frequent lectures in the annex, on electrical topics, are also an admirable means of conveying instruction, and so far as we have been able to watch their progress, they have been heard by very large and remarkably attentive audiences.

THE IMPORTANCE OF ELECTRICAL INDUSTRIES.

A common observation with visitors to the Electrical Exhibition at Philadelphia is that they had never before had any conception of the extent and variety of electrical industries. The exhibition gives a good idea of the applications already made of the electric force, and it more than hints at a good many uses yet to come. The aggregate capital of the firms and companies represented is also enormous, although the leading telegraph companies play a very insignificant part. A list of stock quotations published weekly in France of the principal electrical companies shows a total capital of over three hundred and eighty-five million dollars. The list is in several departments incomplete, and, of course, does not include the capital of governments and private firms. It would, we think, be safe to multiply the amount four times in order to get at the capital invested to-day in electrical applications for the comfort and convenience of mankind.

Railways and Telegraphs.

At Boston, on the 17th, the Massachusetts Railroad Commissioners gave a hearing in accordance with the resolution of the Legislature of 1884 instructing them to investigate the subject of the occupation of railroad locations by more than one telegraph company, including the necessity for and propriety of such occupation, the terms and conditions under which the same may be properly and safely permitted, the character and nature of the structures to be used and the regulation of their construction, repair, maintenance and operation. The various corporations were represented.

Mr. Choate, President of the Old Colony Railroad Company, thought telegraph poles on a railroad were a nuisance except so far as they were needed for the business of the road. The idea of letting any number of telegraph companies put poles on a road and then holding the railroad company responsible for accidents, was preposterous.

Parker C. Chandler, representing the Baltimore & Ohio Telegraph Company, spoke in advocacy of granting rights on railroads to companies other than the Western Union. Mr. D. H. Bates, President of the Baltimore & Ohio Company, considered in detail the legal aspects of the question. The people, he continued, were in favor of competition, but all the companies were opposed at every step by that gigantic monopoly, the Western Union. The telegraph is the natural ally of the railroad, and the two should be in harmony, for they are both of great service to the people. He said that the underground wires in New York had worked fairly well. The obstacles were the expense of placing them underground and the liability to obstruction. A single wire might be worked about a mile, perhaps two miles, but multiplex telegraphy is hindered geometrically according to the underground distance. Mr. Bates was asked what the capital of his company was, but declined to answer until further advised, although the Commissioners decided that the question was a proper one. He said he could not remember the nominal capital of the various sub-companies or the amount of stock issued. He would put the nominal capital at $5,000,000.

A New Feat in Telephony.

The transmitting by telephone of musical sounds, and even of a whole concert or operatic performance, is no longer new; but intelligence reaches us, says the London *Electrician*, from Brussels of a novel phase of this combination in connection with the long-distance telephoning along telegraph wires by the Van Rysselberghe system. The Committee of the Antwerp International Exhibition, to be held next year, and in which electricity will take a prominent part, are providing an additional attraction—magnetic it turns out to be as well as in the showman's sense—in a concert room, where visitors may hear music from Brussels and other places transmitted by telephone through the existing telegraph wires. A trial—not rehearsal—of the arrangements was made a few days ago, and, we are informed, surpassed the most sanguine expectations. The orchestra of the Brussels Opera, playing in the Vauxhall concert kiosque of the Parc at Brussels, was distinctly heard at Antwerp, a distance of about thirty miles. And not only was the orchestral performance distinctly reproduced, but a violin solo, Gounod's "Meditation," was heard in its minutest details, although the ordinary telegraph service was not suspended. Six microphones had been fixed to two small columns of the Vauxhall orchestra, on a level with the musical instruments; and carbon transmitters, of the model devised by M. Van Rysselberghe, mounted in quantity and actuated by a small Faure accumulator, were put in connection with the central office of the Compagnie des Téléphones. From this spot the circuit was continued by a double wire, so as to avoid telephonic induction, so far as the directors' office of the Central Telegraph Station at the Northern Terminus, Brussels. Here ten Bell receivers were intercalated in the circuit, so as to allow of the music being heard (while being transmitted to Antwerp) by the Minister of Railways, Posts and Telegraphs, and the principal officials of the Government Telegraph Department, who warmly congratulated M. Van Rysselberghe on this additional application of his invention. At Antwerp were assembled Professor Rousseau, President of the Electrical Committee of the Antwerp Exhibition, some members of the Commission, several directors of the Bell Telephone Company, Lieutenant Lemière, of the Military Telegraphic Department, Antwerp; M. Charles Mourlon, manager of the works where M. Van Rysselberghe's apparatus is made, and M. Berlin, superintendent of the arrangements for adapting the Belgian telegraph wires for telephoning, under whose direction this interesting trial took place.

Lion Taming by Electricity.

The latest application of electricity, according to the *Pall Mall Gazette*, is an invention made in the interests of lion-tamers, which consists of an apparatus of great power, shaped like a stick, about 3½ feet in length. M. Rauspach, the inventor, is a lion-tamer himself, who has been "a good deal worried" during a long and successful professional career. He has already experimented with it upon the denizens of the cages in his menagerie, and relates the different effects upon the brutes. Three of his lions receiving the shock, immediately showed signs of the greatest terror. They were seized with trembling and growled fitfully. The tiger was more quickly subdued, became stupefied, and crouched in a corner of the cage. Bruin was more refractory to electricity, which seemed scarcely to affect him. He would growl and show his teeth and was subdued after repeated discharges. The most astonishing effects, however, were perceptible in the boa constrictor. On receiving the discharge the specimen from Cayenne, nearly twenty feet in length, became at once paralyzed, and remained motionless for six hours afterward. When he recovered he showed signs of numbness for three whole days. Finally, the elephant on being electrified by a touch of the stick upon the tip of his trunk, set up a series of wild cries, and became so strange that the tamer feared the brute would break its heavy iron chain. M. Rauspach is said to intend addressing a paper upon the experiments to the Academy of Sciences. His discovery in time will be applied to human beings, and a flash of electricity will be prescribed as a certain cure for a bad temper. What would we not give to silence some people for six whole days!

EUROPE IN AFRICA.—A new telegraph system is in course of construction in Tripoli, from the frontier of Tunis on the one hand to Egypt on the other.

The Van Depoele System at the Exhibition.

The operations of the Van Depoele Electric Light Company, of Chicago, have hitherto been confined chiefly to the West, the reason being that their system found a ready acceptance in that part of the country, and that they were called upon from time to time to increase their manufacturing plant in order to meet an immense local demand alone. However, the reputation of their system is now widely spread, not alone in the United States, but in Canada, and the company have, with great enterprise and at considerable expense, come East to show what they can do. They have fitted up a very extensive exhibit at the Electrical Exhibition. It includes a 60-light machine, a 20-light and a 12-light. They show also an 8 horse-power generator for electric motors, two electro-plating machines, seven motors ranging from one-hundredth of a horse-power up to 10 horse-power, and thirty-six sewing-machine motors. They exhibit also an arc light, to run from 18 to 20 hours without renewing the carbons and that can be held in any position without detriment to the light. There are also two focussing lamps for steamboats, and an induction machine for distributing currents for the use of incandescent and other lights. In the gallery the company have one of their spaces fitted up elaborately as a room, with rich furniture and hangings and with their lights. The effect is extremely tasteful and pleasing, and, in common with the rest of the exhibit, this display attracts much attention.

We illustrate on this page the chief features of the exhibit, namely, the machines and lamps. Fig. 1 gives an end view of the dynamo, evidently a machine of strong and compact build. The parts are few. The field magnets consist of two large coils of copper wire wound around two soft-iron cores, which are cast on one end to heavy back plates, the other end being secured to the semi-circular pole pieces between which the armature revolves. The back plates of the magnets are set firmly between top and bottom plates, holding the whole in position and making a solid frame. At the centre of the lower plate are two extensions upon which stand the supports for the armature shaft. Thus the frame is a long electro-magnet, having its poles inverted toward the centre. The Van Depoele armature consists of a number of iron bars, separated from each other, and riveted to the inner and outer periphery of two metal rings, several of these rings being placed between the inner and outer layer of iron bars. The rings and bars are riveted together, forming one strong piece. Thus an opening is provided all along and around the whole core, and while the entire winding is subjected directly to the field of force, this style of construction prevents heating and obviates artificial ventilation. It is also pointed out as one advantage offered, that magnetization and demagnetization are effected instantaneously—the bars being wound in couples with one section of wire, and the bars not touching one another. The commutator is made up of a large number of copper sections in the usual manner. The adjustment of the brushes can be seen in Fig. 1.

The current supplied by the Van Depoele machine is, as will be inferred from the nature of the construction, of low electromotive force and great quantity, and we expect soon to publish figures and fuller details on the subject. The lamps burn with short arcs, and give a remarkably white, steady light. The machines from twenty lights up are fitted with an automatic current regulator, allowing of any variation in the number of lights burning. Fig. 2 shows the Van Depoele electro-plating machine, from which excellent work has been obtained. The report on it states that twelve plates, 18 × 24 inches, have been got out in two hours with ease, the deposit being perfectly smooth and tough.

We give also illustrations of three Van Depoele lamps, the Standard, Universal, and the Double Service for street use. The leading features of the Standard lamp, Fig. 3, are two electro-magnets, one in the main and one in the shunt circuit; to the latter is hinged a soft-iron armature, the free end of which moves under the influence of the opposite pole of the main magnet. This armature carries the carbon lifter, so that any motion imparted to the armature under the influence of its electro-magnets, is directly communicated to the lifter, either separating the carbons or allowing the same to feed. The lamps need no occasional adjustment, thus doing away with all tampering by attendants, which has in many cases caused the failure, within a short time, of a good many plants. It is provided with an automatic and hand cut-out.

Fig. 4 represents the Van Depoele Universal lamp. This lamp is intended to be used wherever an ordinary lamp could not be introduced successfully—on high and exposed places, such as towers and the like, or in places where there is much dust, dampness, etc. It has no rod, the carbons being held in place and fed by an endless copper belt This belt is actuated by a small electric motor, simple in construction, and placed on the top of lamp. The lamp can be placed horizontally or turned upside down without in the least affecting the proper feeding of the same. Carbons twenty-four inches long can be used in cases where long runs are needed.

Fig. 5 shows the Double lamp, sixteen hours' service, intended to be placed on high poles, such as are used in street lighting, etc. This lamp is provided with a solid frame, by which it is held in position.

The particulars we have entered into above are intended more to give an idea of the chief portions of the exhibit than to describe all the minute details and distinctive principles of the Van Depoele system. The company have paid almost as much attention to the transmission of power as to lighting and plating, and we hope at an early date to speak more specifically of their efforts in that direction as well as of the general points now left unnoticed. It is the intention of the company to seek a much wider field for their operations, having the encouragement of success in all work hitherto undertaken.

FIG. 1.—END VIEW OF VAN DEPOELE DYNAMO.

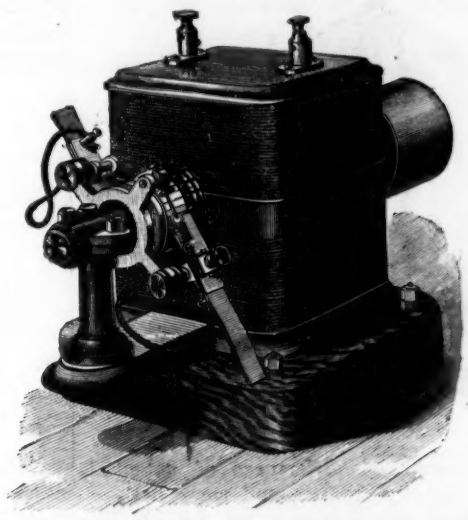


FIG. 2.—THE VAN DEPOELE PLATING MACHINE.

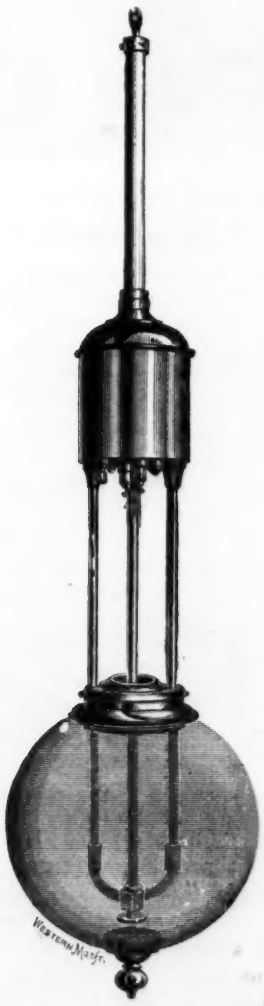


FIG. 3.—STANDARD LAMP.

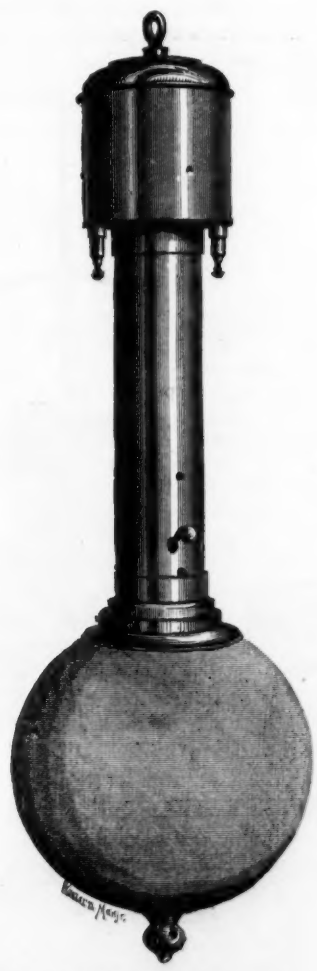


FIG. 4.—UNIVERSAL LAMP.

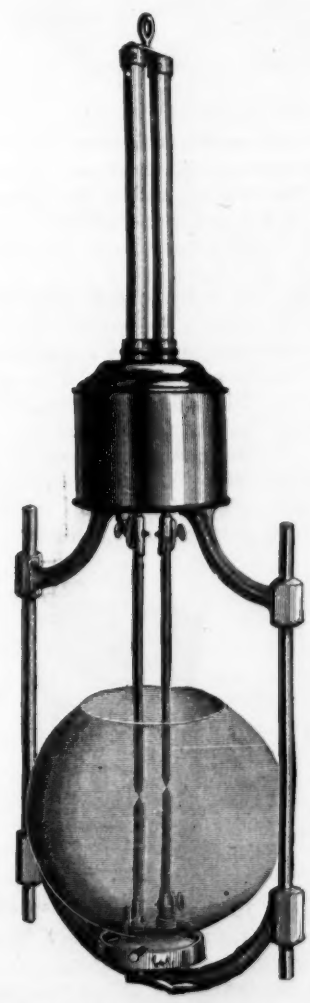


FIG. 5.—DOUBLE SERVICE STREET LAMP.

Galvanometers at the Electrical Exhibition.

When the name *Galvanometer* was first used it did not have the broad significance it now has. It is now a generic name for instruments which we specify by such adjectives as "testing," "tangent," "sine," "astatic," "reflecting," "horizontal," "vertical," "projection," "torsion," "differential," "marine," "dead-beat," etc., such as denote their mechanical construction, use, manipulation, or some other characteristic.

But within a few years we have come to use more specific terms to denote the special uses to which the instruments are put. It is not always sufficient to test for the existence of a current alone; we often desire to learn its magnitude and other values. So our galvanometers are by process of winding, length of wire in coils, the use of natural or artificial magnetic fields, etc., divided into three

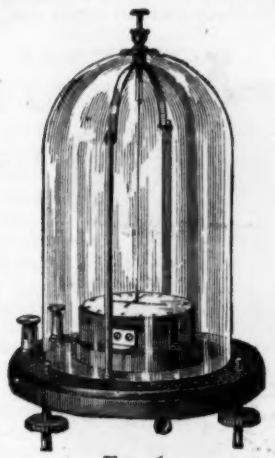


FIG. 1.

clases, namely, measures of differences of potential, strength of current, and of resistance, and we call them, appropriately, potential galvanometers, or volt-meters; current galvanometers, or ampère meters; and resistance galvanometers, or ohm-meters.

Many of the forms of galvanometers are due either to taste, convenience of transportation and of manipulation. or to some necessity in specific cases.

The Electrical Supply Company, of New York, exhibit many galvanometers of Elliott Bros.' make, the enumeration even of which would take much of our space. We illustrate a few of them. Fig. 1 is a simple horizontal astatic galvanometer, of low resistance, suitable for thermo-electric currents, and for measurements of conductivity of wires. It is a laboratory instrument. There are varieties of this instrument. Figs. 2 and 3 show a portable

FIG. 2.

FIG. 3.

astatic galvanometer, by same makers, with jeweled needle-centres, upwards of 1,000 ohms resistance of coil. It has a leather case and a small bar-magnet with which to bring the pointer to zero. Fig. 4 is a detector galvanometer with vertical needle, and Fig. 5 is a like instrument with three resistance coils of 2, 10 and 1000 ohms.

Fig. 6 shows one of Gaugain's tangent galvanometers, having 4 different coils. Fig. 7 shows the horizontal astatic galvanometer of high resistance, which is the favorite for testing in telegraph stations in Europe. Figs. 8, 9, 10 show various forms of Sir William Thomson's reflecting galvanometers. Figs. 8 and 9 show the ones which are now so extensively used in the measurement of potentials. They have coils of upwards of 5,000 ohms resistance. Some are made differential. Fig. 11 shows Sir William Thomson's marine reflecting galvanometer, having coils

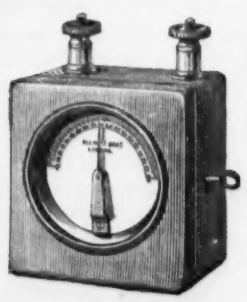


FIG. 4.

FIG. 5.

of upwards 20,000 ohms. Fig. 12 shows Latimer Clark's differential galvanometer, with the necessary plugs, keys, etc. Figs. 13 and 14 show speaking reflecting galvanometers, used in testing sub-marine cables. The former has coils of high resistance. The latter has coils of low resistance, and an oil-vessel and vane to turn therein, as shown, to stop the vibrations of the needle.

Fig. 15 shows Sir William Thomson's potential galvanometer. This instrument consists essentially of a coil of insulated copper or German silver wire *C*, the resistance of which is generally over 5,000 ohms, fixed to one end of a platform *P*, on which a magnetometer *M* rests. The magnetometer *M* is supported on three feet and a spring; two of these feet slide in a V groove, cut in a slip of hard wood let into the top of the platform *P*, and this allows the magnetometer to be moved nearer to or further from the coil, but prevents it being so turned round as to change the zero reading of the instrument.

To set up the instrument for use, place it with the plane of the coil in the magnetic meridian by turning the instrument until the index of the magnetometer points to zero on the scale, and level it by turning the screws shown at the front of the platform, until the bubble of the circular level attached to the magnetometer stands in the center of the level. The sensibility of the instrument is changed by changing the position of the magnetometer on the platform. When the front of the magnetometer is placed at any division of the scale marked on the platform, the number stamped at that division indicates the deflection in divisions of the magnetometer scale, produced by one volt difference of potential between the ends of the coil; the intensity of the magnetic field in which the magnetometer needles are placed, being supposed unity. The approximate intensity of the horizontal component of the

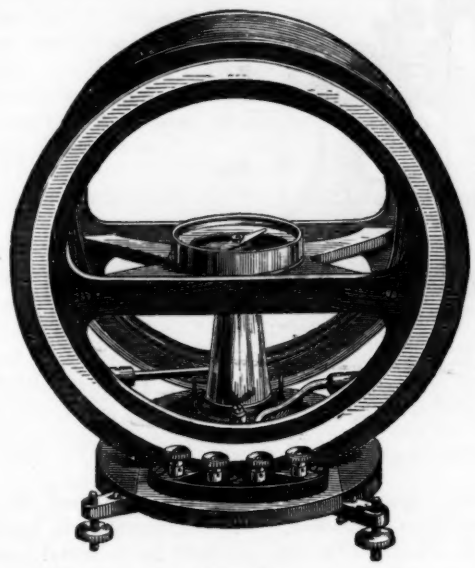


FIG. 6.

earth's magnetism at several places is given in the books, but it must be borne in mind that the value of this element may be greatly altered by iron or magnets near the place of observation. This varies in different places in Great Britain from .181 to .156. Like variations exist in this country.

In order to avoid as much as possible errors due to changes in the magnetic field produced by local influences, a permanent magnet of semi-circular shape is supplied with each instrument, for the purpose of producing a field at the magnetometer needle much more intense than that of the earth. This magnet is placed on the magnetometer in the position shown in Fig. 15, and its field brought into parallelism with that of the earth by turning the screw at the point of the magnet until the index points to zero.

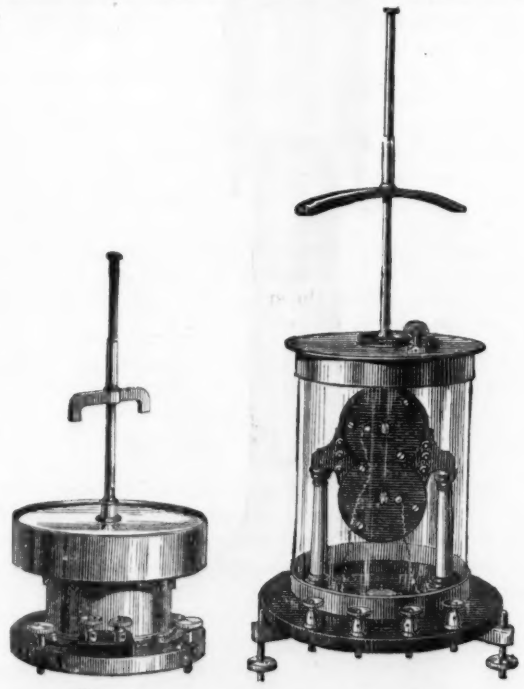


FIG. 7 FIG. 8.

The absolute intensity of the magnetic field at the needle, due to this magnet alone, is carefully determined, and marked on the magnet before the instrument is sent out. The total intensity of field is obtained by adding the horizontal component of the intensity of the earth's field to the number marked on the magnet. To avoid accidental demagnetization of the magnet, it must be kept at a distance from all other magnets.

In order to facilitate the use of the instrument, a pair of flexible electrodes, about four yards long, are supplied along with it. These electrodes are shown attached to the instrument in the figure. The spring-clips attached to the ends of the electrodes allow the instrument to be readily put in contact with two points of a circuit. To prevent a current passing through the coil when no reading is being taken, a key is placed in the circuit of the coil. This key should on no account be short-circuited, because the coil becomes heated when a continuous current is allowed to flow through, and consequently increased in resistance, thus causing its indications to be too small.

To determine the difference of potential between two points of a circuit, an electrode is clipped on at each of the points and then the key depressed and the deflection noted. If the deflection be too great the magnetometer must be pushed to a division further from the coil; if too small, to a division nearer the coil. The number of divisions in the deflection is then to be multiplied by the num-

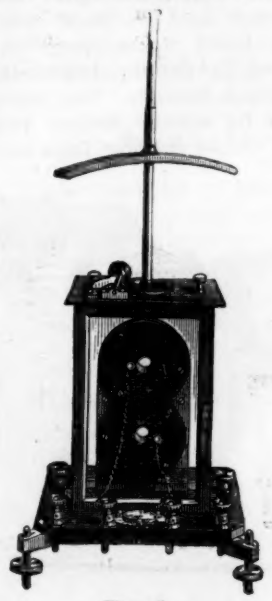


FIG. 9.

FIG. 10.

ber on the magnets, plus, say, .17 for the earth's force, and divided by the number at the division of the scale on the platform exactly under the front of the magnetometer; the result is the difference of the potential in volts. That is to say, the co-efficient for volts corresponding to any division on the platform scale is obtained by dividing the intensity of the magnetic field by the number at that division. When the difference of potential to be measured exceeds 200 volts, the readings of deflection must be taken as quickly as possible on account of the rapid heating of the

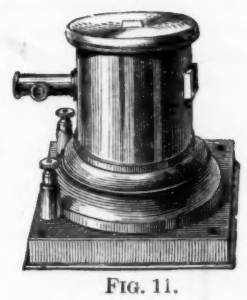


FIG. 11.

FIG. 13.

coil. The rise of temperature for any short time T may be taken as $v = \frac{E^2\ T}{R\ F\ K}$ where E is the difference of potential and R the resistance in absolute measure, T the time in seconds, F Joule's mechanical equivalent of heat, and K the thermal capacity of the coil.

For example, let $E = 200$ volts.
$R = 5{,}000$ ohms.
$T = 30$ seconds.
$F = 4{\cdot}2 \times 10^7$.
$K = 400$.

Thus $v = \frac{200^2 \times 10^{16} \times 30}{5 \times 10^{12} \times 4{\cdot}2 \times 10^7 \times 400} = 0^{\circ}.17$ C. rise of temperature. The temperature of the coil at which the numbers on the platform scale are correct is stamped on the instrument. A table accompanying the instrument

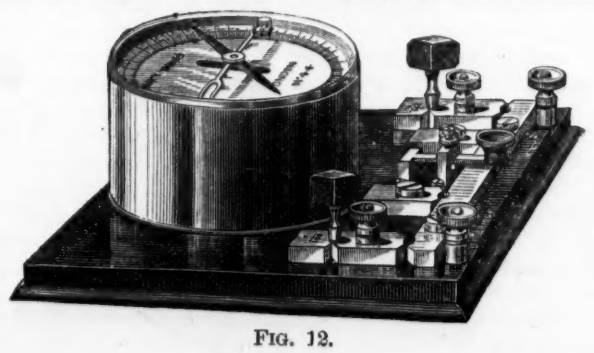


FIG. 12.

gives the co-efficients by which the deflections must be multiplied when the temperature of the coil differs by any number of degrees less than 20 from the temperature at which the instrument is correct.

Fig. 16 shows Sir Wm. Thomson's current galvanometer. This instrument is similar in form to the potential galvanometer, with the exception that the coil is made up of a few turns of thick copper strip, and has a resistance of only about $\frac{1}{1000}$ of an ohm. Any current, the intensity of which is less than 100 ampères, may be safely measured by this instrument. Messrs. J. W. Queen & Co. exhibit one of

these instruments for measuring up to 1,000 ampères. The numbers at any division of the scale on the platform indicate the deflection which an ampère of current produces when the magnetometer is set with its front edge at that division and the intensity of the magnetic field is unity. The mode of setting up this instrument for use is precisely the same as that described above for the potential galvanometer.

To find the number of ampères corresponding to a deflection—

RULE.—Multiply the number of divisions in the deflection by the number on the magnet, plus 17 for the horizontal intensity of the earth's field, and divide by the number at the division on the platform scale exactly under the front of the magnetometer.

Terminal pieces of the form shown in the figure are attached to the coil of, and to the electrodes supplied with the instrument. When the electrodes are being removed from the coil or from the leads, the two sides of the spring terminal piece should come into contact with each other before they are out of contact with the plates of the other terminal pieces. By attending to this the circuit is not interrupted, and hence sparks are avoided. A separate terminal piece, shown in the figure with two short wires attached, is also supplied, for the purpose of allowing the galvanometer to be easily introduced or removed from the circuit. This terminal piece is made to form part of the circuit, the current through which is to be measured. By adopting this arrangement the galvanometer can be readily removed from one circuit to another.

(TO BE CONTINUED.)

The Telephone in South Australia.

In the year 1880, Mr. Todd, the Postmaster-General of South Australia, submitted a memorandum to the Minister of Education, says the *South Australian Register*, in which he recommended the Government to establish a telephone exchange; and in 1881 a bill was introduced in the House of Assembly by the Hon. J. L. Parsons for the purpose of giving effect to the scheme Mr. Todd proposed. The bill gave the Government the exclusive right to erect and maintain telephone lines in the colony, and it rapidly passed through both houses of the Legislature, the only objection raised to it being based upon an erroneous assumption that it would interfere with the success of the telegraphic system, and would not contribute anything to the revenue.

Mr. Todd selected the Blake transmitter, the Bell receiver in the form known as the "Ponycrown," and the "Swiss" telephone.

The act was first brought into operation in 1882, when a number of private lines were laid down and leased, and the telephone exchange was not opened until May of last year. At that time the number of subscribers was only twenty-five, whereas the number at the present time is 263, of which 217 are connected with the Adelaide Exchange, and 46 with the Port Adelaide Exchange. In addition to this there are 156 private lines. This is very satisfactory progress, and considering its age, the exchange will now bear favorable comparison with the exchanges in the other colonies.

The number of subscribers in the other colonies at the commencement of this year was as follows: Melbourne, 650; Ballarat, 81; Sandhurst, 37; Sydney, 260; Dunedin, 237; Auckland, 151; Christchurch, 125, and Wellington, 60. There are about 700 sets of telephones now in use, and the greater proportion of these have been purchased of the Western Electric Telegraph Company of Chicago, whose instruments are considered to be superior to those manufactured in England.

The total length of wire erected is 983 miles, and the longest telephone lines are the following: Government House to Marble Hill, 13 miles; McCulloch—Goolwa to Port Victor, 11 miles; Cave & Co. (S. A.) to Crafers, 10 miles. Mr. Cave joins his Port wire to the Crafers line, and the length is thus increased to 18 miles. The above does not include the railway telephone lines, the longest of which is from Kapunda to Northwest Bend, 56 miles, and from Burra to Petersburg, 55 miles.

The charges made to subscribers are lower than those imposed by the postal authorities in England, and some special facilities are afforded, some of which do not pertain elsewhere. For instance, Clause 14 of the regulations provides that chemists situated along any existing line of telegraph or telephone within a distance of five miles from a telephone exchange may be connected with such exchange on payment of subscription of £12 per annum, on the understanding that persons will be allowed to consult any medical subscriber on the payment of 6d. for every five minutes, or free of charge where the medical subscriber pays the additional £9 a year. The telephone must be available for purposes of medical consultation day and night; but a private fee of 2s. may be charged during the night.

The Economy of Electric Lighting.

Three hundred incandescent electric lights illuminate the Belmont and Spring Garden pumping stations, Philadelphia, at a cost of $2,000, as against gas bills of $4.800, formerly paid for gas consumed at Spring Garden station alone. Until a year ago Belmont station had no means of lighting other than hand lamps, which, aside from the danger from their use, smoked the walls and machinery. An electric plant, consisting of an engine and dynamo furnishing power for 100 lights, was introduced at a cost of

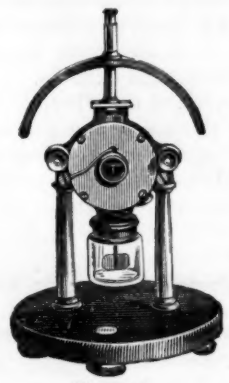


FIG. 14.

$2,812.53. The running expenses for the first year were $768.05, which will be much less for the current twelve months. The expenses at the start were increased by the reason that the current had been placed too high, burning out about 150 lamps before it was reduced. Instead of sixteen candle-power, the current was set for four candles higher. The authorities estimate that the cost of gas to light this station would be about $3,000 a year. In less than two years the saving by using the electric light would pay for the plant and cost of its operation.

At the Spring Garden station the electric light has been used in the old building for some time, and during this week the new structure, the forebay and the outbuildings will be lighted by the new illuminator. A plant comprising two engines and two dynamos, furnishing power for 200 lights, has been placed in the works at a cost, complete, of $6,176. The yearly expenses for gas had been $4.800, and the light was indifferent compared to the electric spark. With the completion of the improvements at Spring Garden station the spot will be one of the most attractive on the river drive in the Park.

Electric Light Carbons.

The United States Electric Lighting Company, of this city, have recently disposed of their extensive plant heretofore used in the manufacture of electric light carbons. The increased demand for the lamps and dynamos manufactured by this company has made an enlargement of their manufactory imperative. It became, therefore, optional with the United States Company either to establish a branch factory for dynamos and lamps, or to sever the manufacture of carbons entirely from their present extensive works. The management of the company found that it would be impracticable to equip a second factory, and they therefore concluded to transfer their carbon machinery to other hands, and employ their entire buildings in the construction of lamps and dynamos in order to keep abreast of their growing business.

Negotiations were commenced some time ago, and have recently culminated in the sale of the entire plant of the United States Electric Lighting Company for the manufacture of carbons, together with the stock and good-will of their carbon business, to the Boulton Carbon Company, of Cleveland, O.

After making the most critical tests of all the different carbons manufactured in the world, the United States Company came to the conclusion that the "Boulton" carbons were better adapted to their system than any other carbon candle made. Hence this arrangement.

We understand that the Boulton Company have been for some time making large shipments to foreign countries, including England, France, Germany, Belgium, Holland and South America, having successfully established their carbons in the face of foreign competition. They have now in process of construction at Cleveland the largest carbon factory in the world, which will give them a working capacity of something like 100,000 carbons a day. The improvements in their machinery and process of manufacture, covered on the necessary points by letters patent, enable them to produce superior carbons at the lowest possible cost. The Boulton Company also manufacture, beside the carbon points, carbon plates for electrical batteries, diaphragms for telephone transmitters, and transmitter buttons, carbon cups, which have recently come into quite extensive use, and every form of carbon required in the development and use of electricity.

This is regarded in electrical circles as the most important negotiation that has recently taken place in connection with electrical industries.

The Bell-Drawbaugh Suit.

Argument has been heard during the week before Judge Wallace in the United States Circuit Court, in the infringement suit of the American Bell Telephone Company against the People's Telephone Company, representing the Drawbaugh claims. The Bell Company are represented by ex-Senator Roscoe Conkling, Messrs. Storrow and Smith and Dickerson & Dickerson as counsel, with Prof. Charles U. Cross and Frank L. Pope as experts. The People's Company are represented by Senator Edmunds of Vermont, ex-Judge Lysander Hill, Messrs. T. S. E. Dixon, M. W. Jacobs and Melville Burch, as counsel, with Mr. Park Benjamin as expert. A great deal of interest has been shown by the business public in the proceedings, and the number of electricians in attendance from time to time has been large. The arguments have gone over the old ground, adding nothing new or striking.

American Institute of Electrical Engineers.

The latest notice issued by the Secretary of the Institute, and dated at the Philadelphia Exhibition, says: The second meeting of the Institute will be held in Philadelphia on Tuesday, Wednesday and Thursday, the 7th, 8th and 9th of October, 1884. A considerable number of papers are already promised for the meeting, and it seems probable that they will excite animated and profitable discussion.

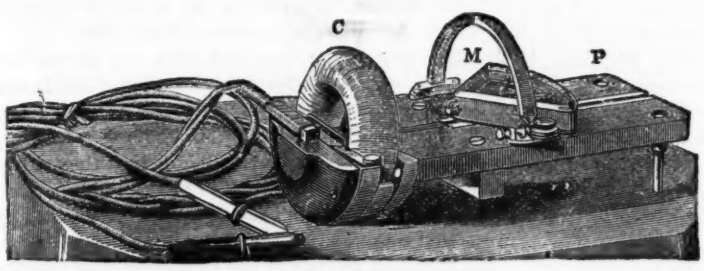


FIG. 15.

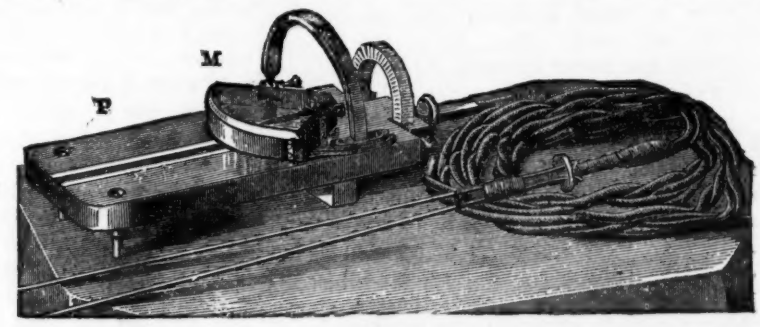


FIG. 16.

The International Electrical Exhibition will then be at its best. Special tickets and privileges will be extended to the members by the managers of the exhibition. Negotiations are pending for special railroad and hotel rates to those members who attend the meeting. Those who expect to attend must send their names, and those of the ladies (if any) who expect to accompany them, to the secretary, at the address below, in order to secure railway facilities, reductions, etc. A supplemental circular will be mailed to the members in a few days, giving further announcements, and the terms, etc., of railroad, hotel, exhibition and other accommodations, the hall of meeting, etc. The Institute has a room in the Exhibition Building for the exclusive use of its members. Immediate notice should be made to the secretary of intention to read papers at this meeting, with the titles of such papers, so that they may be timed as to reading and duly announced. Propositions for membership should be sent to the secretary as early as possible. Proposed members and associates have all the privileges extended to members at this meeting, including the reading of papers, engaging in the discussions, etc., etc.

SUING THE B. & M.—Edward Middleton, the telegraph line contractor, of Philadelphia, has brought suit in the Common Pleas Court against the Bankers' and Merchants' Telegraph Company on two promissory notes for $30,000 each. Mr. Middleton received the notes in payment of work performed in extending and renewing the lines of the company, and is a creditor to the extent of $120,000. Suits have also been brought against the company by Mr. Middleton in New York and Connecticut.

THE MACKAY-BENNETT CABLES.—The first Mackay-Bennett cable has already been used, and considerable progress is reported with the second. A special dispatch of the 15th inst. from London to the New York *Herald* says: "A large number of the members and associates of the Society of Engineers have been visiting the telegraph and cable works of Messrs. Siemens and witnessed the coiling of the last portion of the Mackay-Bennett cable in the Faraday. They examined how the cable was tested in the ingeniously contrived pressure tank, representing the average pressure of the ocean, and they pronounced the new cable the most interesting, accurate and wonderful yet fashioned."

Exhibits at the International Electrical Exhibition.—II.

We continue below our notes on the leading features of the Exhibition :

THE OTTO GAS ENGINE.

One of the most interesting exhibits, and one that attracts a good deal of attention from visitors, is that made by Messrs. Schleicher, Schumm & Co., builders of the well-known Otto Gas Engine, whose establishment at the corner of Thirty-third and Walnut streets, Philadelphia, is capable of turning out between six hundred and seven hundred engines annually. The space allotted to them in the exhibition building is at the west end of the main hall, near Thirty-third street. In it they have placed three Otto engines, one of fifteen, one of seven, and one of four horse-power. The last drives an Edison dynamo, furnishing twenty-five incandescent lights; and the seven horse-power engine drives a Bernstein dynamo of a capacity of forty-two incandescent lamps.

The motive power of these engines is derived solely from the combustion of ordinary illuminating gas within the cylinder. The gas, mixed with the proper quantity of air, enters the cylinder. It is then compressed and ignited, producing immediately a pressure of 180 to 200 pounds per square inch. By this means the piston is put in motion. The gas is admitted to the cylinder by means of a very sensitive automatic valve, which supplies the exact quantity necessary to the maintenance of the normal speed of the engine, whether the power transmitted by the belt be the maximum or minimum amount. Hence the cost of running is exactly proportionate to the work required—always varying with the load.

The automatic valve is a valuable part of this style of engine. By observing, simply, the number of times per minute that the gas is admitted into the cylinder, the exact indicated horse-power developed by the engine at the time can be easily computed, because every charge of gas produces a definite amount of power, the charges, as already stated, varying with the load on engine.

As is generally known, the incandescent light requires a very regular speed of dynamo. Hence to run a dynamo for incandescent lighting, with the Otto engine, is putting the engine to a severe test. But the brightness of the Edison and the Bernstein lamps, the power for which is furnished by the four and seven horse-power engines in the exhibit, shows that the Otto engine is remarkably satisfactory as regards regularity of speed.

As an evidence of their confidence in the regularity of the engines, Messrs. Schleicher, Schumm & Co. have placed in view a speed indicator that shows the exact variation of speed. They have also placed in full view a large gas meter showing the consumption of gas in tenths of a cubic foot. Thus visitors have all the information desirable before them. On the rear wall of the exhibit are two very large, fine photographs of the works. The one to the left is the erecting shop, and shows a row of engines on test stands. Every engine before delivery is placed on a test stand and made to run several days until all its parts work smoothly, and the indicated and brake power, and the gas consumed, are up to the standard. The other view shows one of the rooms containing machinery specially adapted to the construction of the engines. The firm do no other work than the construction of Otto gas engines, of which there are now about 12,000 running.

THE STANDARD ELECTRICAL WORKS.

A fine display is made in space 18 on Avenue H of the main floor by the Standard Electrical Works of Cincinnati, O., who exhibit all their specialties, including the Painter patent ring-off magneto telephone bell, the McFall patent combination bell, Post & Co.'s patent combination bell, their latest gear wheel, with push button or without, extra-territorial bells, extension bells, Philadelphia and St. Louis Law bells, and various other kinds of magneto bells. The collection is a most interesting one. The exhibit includes also ordinary switch-boards, club switch-boards, generators, annunciators, Stevens' top contact telegraph key and the well-known Stabler individual call system. All these are set up in working order and are clearly explained to all who wish to know their mode of operation, by the eastern agent, Mr. J. C. Kellar, who is in charge.

THE SPELLIER ELECTRIC CLOCK SYSTEM.

Mr. Louis H. Spellier, of Philadelphia, has a space near the offices of the Exhibition management on the main floor, and a number of his clocks are distributed throughout the building. His system is highly ingenious, and although invented in this country, has certainly gained greater celebrity in Europe than it has here. Many of the standard European books on electrical appliances bestow warm praise on the Spellier system. We hope to bring, in a later issue, a detailed description of the Spellier system before our readers. In passing, we may note that two years ago it received from the Committee on Science and Arts of the Franklin Institute, the Elliot Cresson gold medal, an award given but eight times in thirty-two years. One great feature of the system is, that it avoids the blows produced by the sudden check offered to the armature when closely approaching the pole of the electro-magnet. This is, however, but one of its merits. The movement, exposed to full view and working a large clock dial, is almost the first thing to catch the eye on entering the Exhibition from the doors at the lower end, or by the bridge connecting with the annex.

VACUUM OIL COMPANY, ROCHESTER, N. Y.

Among the practical displays at the exhibition is a collection of samples of oils manufactured by the Vacuum Oil Co., of Rochester, N. Y., and a great many signs are to be seen all over the building with the announcement that the machines on which they are placed are using the Vacuum Company's lubricating oil. The question of oil is an important one with most electricians in charge of machinery, especially those operating plants for electric lighting and the transmission of power ; and as the machinery oils of this company are graded to all rates of speed, they are naturally receiving a good deal of attention. A representative of the company is in charge of the exhibit, and explains to all interested the uses of these lubricators.

WALLACE & SONS, ANSONIA, CONN.

It was at first proposed by the authorities to place the exhibit of this celebrated firm in the historical collection, where it undoubtedly deserved a place ; but it is now to be found on the main floor, and, very appropriately, in the midst of all the electric light exhibits. A more interesting display is not to be found anywhere in the building. It includes the early dynamos manufactured by the firm when electric lighting was in its earliest infancy, and even before it can be said to have had any practical existence. The first dynamo-electrical machine built by Wallace & Sons was in July, 1874. But for many years previous to the building of this first machine they had manufactured different kinds of electrical apparatus, among which were the large electro-magnet at Stevens Institute, Hoboken, N. J., one for the United States Government at West Point, one for the University of Pennsylvania, one for Yale College, and a large Ruhmkoff coil from which a spark twenty-six in. was obtained. The 6-in. depositing machine here is duplex, can be used as two separate machines, or connected as one. It has twelve field magnets, sixty-two coils on the armature six brushes on each of the two commutators. This machine was exhibited at the Centennial, Philadelphia, 1876. The Wallace eight-inch electric light machine, was one of the six machines built to light up the grounds of the Centennial Exhibition, Philadelphia, 1876. Three of these machines were used there. One of them was running most of the time, day and night, and frequently three of them, supplying light for three arc lamps on the top of three of the towers of Machinery Hall. One evening, and only one, the Hall was opened to visitors, and on that occasion an arc light with reflector and colored glass was used to illuminate the waterfall, producing a beautiful effect. This was the only American electric light exhibited at the Centennial, and the only one used to light up the grounds. During the exhibition Mr. Wm. Wallace, while experimenting at the manufactory, succeeded in running electric lights in series, and the machines ever after were used with the lights in series.

In 1878 they were simultaneously exhibited at the American Institute, New York ; Massachusetts Mechanics' Fair, Boston, and Maryland Institute, Baltimore ; the lights at all three of these exhibits being run in series. This machine has four large electro-magnets for field of force, and fifty coils on the armature. The Magneto-Electric Telemachon was built in 1875 as a light machine, and has produced a light of 15,900 candle power as measured by Moses G. Farmer. It was found to make a good electric engine and was so used at the Centennial, Philadelphia, 1876. The armature of this machine is of peculiar construction. Instead of a solid iron ring to wind the wire on, as in the Gramme armature, twenty-four plates of soft iron were used, insulated from each other. The twelve field coils are so connected as to produce two powerful magnets completely inclosing the armature. With an 8-inch light machine, running at a speed of 900 revolutions, Thomas A. Edison was able to run this machine at Wallace & Sons' manufactory, October, 1878, at a speed of 3,500 revolutions. At the Philadelphia 1876 Centennial, it was in almost constant motion during the five months at a speed of 2,500 revolutions. The Wallace machine, built 1879, has a field of force of peculiar construction, which admitted of many changes to determine the best magnetic field with the least amount of wire. There are seven coils on each leg of the magnet, and each one has more convolutions than the one preceding it, thus gradually increasing the magnetism from the neutral point to the ends of the magnet. Changes of series or multiple arc could be made, a single coil of any size could be used, etc., etc. The Pacinotti machine has an armature of 16 coils, each coil weighing only one-half of a pound, and for the weight of wire (8 lbs.), has given good results. This was built November, 1877. The Pacinotti Ring with Wallace field coils, was built February, 1878, to cut the magnetic curves of the field coils in the same direction. This machine has a hollow shaft, the wires from the armature pass through this shaft, and each wire is fastened to its appropriate bar of the commutator, and it also has adjustible brushes. The Wallace-Edmans machine reverses the usual course. The armature remains still and the field of force magnets revolve. It is so constructed that the current from one-third of the armature coils can be utilized to feed the field coils, and the current from the other two-thirds used for light, or all the armature coils may be connected together and a current from another machine used to feed the field coils. The White lamp is one of the six that were made to be used at the Centennial. Three of them were used there, one nearly every day all day long during the whole time. They are focussing lamps and were used with large parabolic reflectors. The exhibits include also the Factory lamp, the Wallace plate lamp, the 48-point lamp, the Wallace-King lamp and other highly interesting apparatus.

THE NOVELTY ELECTRIC COMPANY.

The exhibit of the Novelty Co., of Philadelphia, is one that commands attention. They have an extensive line of toys—boats, engines, machine shops and motors of various descriptions—showing the application of the electric current. By means of dummy doors and windows in conjunction with very complete and elaborate annunciators, they show how a burglar, opening a door, rings the bell, lights the gas, and himself locates his own exact position. Lighting gas by electricity in its various applications, from the burner itself or from buttons placed at convenient points in the house, is also shown and explained. They also exhibit a patented steam vessel indicator, which hangs in the pilot house, and by means of electric connections attached to the engine, records automatically and instantaneously the action of engine. This shows the pilot at once whether his signals are understood. Clark's electric train-signal is also shown. In case the train "breaks," a bell announces it instantly in the cab of the engine. The bell-rope is connected in same circuit for convenience of conductor. Several styles of watchmen's detectors, a fire-alarm system, announciators, burglar alarms, etc., are worthy of description did our space permit.

The Late Volckmar.

To the Editor of The Electrical World :

SIR: Mr. Dell adds to his signature "Secretary of the Electrical Power Storage Co.," otherwise I should not have known who he was, his name being perfectly unfamiliar to me. He is evidently writing about things before his time, and evidently knows but little of what he speaks, his experience in the storage battery business having probably been very short. Undoubtedly Mr. Dell is merely acting as Mr. Sellon's mouthpiece ; I will, therefore, bear upon the few points whereon Mr. Dell has attacked the correctness of my statements.

Inventing an electrical accumulator and patenting other people's inventions are two very different things. It has often been said that one patent is quite as good as another with the general public, and in England where the affidavit of an applicant (under the old law) was deemed sufficient proof for the issue of a patent, Mr. John S. Sellon and the late Volckmar might be paraded as inventors.

It was long since recorded that the Electrical Power Storage Co. could get no guarantee from the inventors of the value of the papers they received from the government. I am acquainted with Mr. Sellon's verbose patent, and also Mr. Swan's patent. I grant that they are patents, but upon such slender claims to put up John S. Sellon as inventor of the storage battery is a pretension as disgraceful to the pretender as disgusting to any electrician.

With the full history of the transactions of the Electrical Power Storage Co., and of the late Volckmar, together with later developments which pertain to Simon Philippart, all at the present time public property, as contained in the columns of the London *Electrician* of 1882, 1883, it requires either excessive ignorance or consummate impudence to attack the meagre statements of that scandalous affair on which I only slightly touched.

It would have been a curiosity if Mr. Dell had defined what Mr. Sellon ever invented, or Volckmar, who was with me and a junior in the establishment of Mr. Camille A. Faure, and under whose signature I hold in writing a proof of the fact. Subsequently, when he was experimenting in Portpool Lane, London, and showing John S. Sellon what an accumulator was, as invented and used by Mr. Camille A. Faure, the era had not then arrived when John S. Sellon had the audacity to put his name forward, even through one of his employés; but the time seems now arrived, the presumption being that the public have forgotten

Passing on to the late Volckmar, I see Mr. Dell does not deny what I stated about him, as far as the Electrical Power Storage Company is concerned; but I see that Mr. Dell asserts that his company possesses the Faure patents. Here Mr. Dell makes another error, or a willful mistake, which, in virtue of his office, he ought to be aware of, having on file, addressed to his company, letters from Mr. Camille A. Faure warning his company from continuing to infringe upon the rights of the inventor

The pretensions of the Electrical Power Storage Co., which have arisen from the Sellon, Volckmar and Philippart intrigues, yet remain a mystery to the general public. Perhaps Mr. Dell may be willing to unravel this tangle, if not, let us hope it will be done for him before long, at the termination of litigations which seem to have surrounded the electrical accumulator up to the present time, and from which I, for one, hope it will emerge, and be of some advantage to its real owners, and not to mere pretenders, who obtain patents on the difference that exists between a square hole and a round hole, and are not satisfied with the glory thereof. VERAX.

NEW YORK, Sept. 17, 1884.

Cut-Outs and Safety Plugs.

We illustrate on this page Mr. Killingworth Hedges' patent safety catches or cut-outs, with fusible safety plugs of albo metal, at the International Electrical Exhibition.

The ordinary form of fuse as used by Edison and others for powerful currents consists of a bar of lead or alloy inserted in the circuit, This plan is attended with some disadvantages common to all fuses containing a mass of metal, which are very uncertain in action, and must be worked at not more than a quarter of their melting point. The rupture of a solid rod also constitutes an element of danger by scattering the molten metal in all directions.

The improved form of cut-out and safety fuse which we here illustrate, is invented by Mr. Killingworth Hedges, of Westminster, and consists of one or more strips of foil composed of a particular alloy, which is found to best resist the disintegrating action of the current. For small currents only one strip is used, but for larger several strips are placed together between layers of mica, and are built up like the leaves of a book, the ends being connected to the terminals as shown. When the current exceeds the amount which can be carried safely, the foil is ruptured through the centre, but the mica itself is not injured, and can be used over again. The mica prevents the metal being thrown about and equalizes the heat, so that it is quite possible to test a number of fuses, and find them all to melt within two per cent. of each other. These cut-outs are very largely used, and have been passed by the fire insurance companies. Fifty, arranged to give way with a current of 60 ampères, also some for 120 ampères, have been employed in the new Law Courts, London, since the opening. They are also largely used for installations with secondary batteries, where a good cut-out prevents the current being discharged in a reverse direction through the dynamo. The number on the mica indicates at what current the fuse will be ruptured; as shown, it will be at 180 ampères.

FIG. 1.

A duplex form of cut-out is shown in Fig. 2, the object of this is to provide a spare fuse of higher melting value; should one fail by reason of excess of current, the spare foil is brought into action immediately by putting over the lever which short-circuits the gap. Mr. Hedges also shows an apparatus for doing this automatically; at the same time the amount of current is controlled by the insertion of resistance, and a warning bell is rung both before and after the fuse is melted.

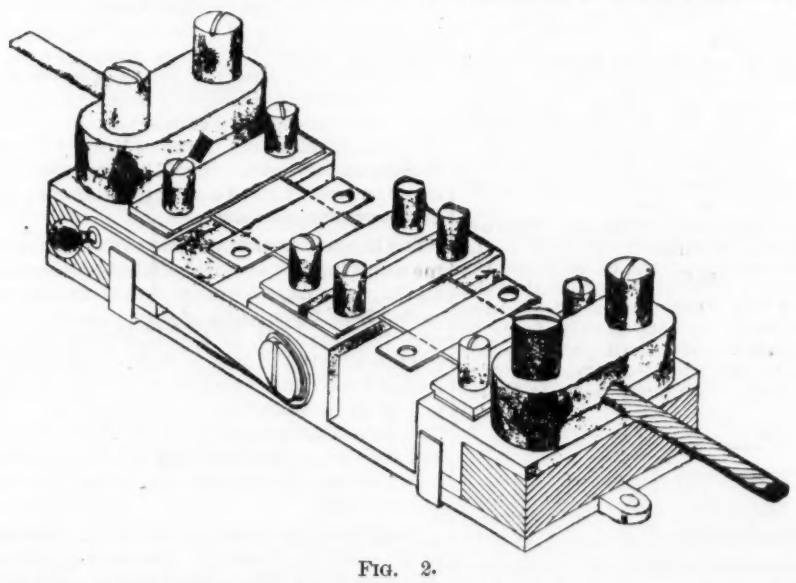


FIG. 2.

Figure 3 is another arrangement of safety fuse, which is contained in a box in such a way that there are no terminals exposed, a very necessary precaution when high E. M. F. currents are employed; the foil and mica support is shown by Fig. 3 *A*. Figs. 4 and 5 are other varieties, especially designed for protecting telegraph instruments from the effects of excess currents where dynamos are used to produce the working potential. The plan adopted by Mr Hedges is very largely employed in England, and has been tested and approved by the officer of the Board of Trade, who, while he vetoes any system which necessitates more than the standard E. M. F., exercises a salutary control over the safety of property from risk from fire, and insists that all currents shall be protected by a device which will bear the test which has been applied to the invention we have described. The manufacturers are the Electrical Supply Company of New York, who exhibit the apparatus in action at the Exhibition.

A Canadian Electric Railway.

The following is a description of the electric railway at the Toronto, Canada, Exposition, as constructed and operated by Chas. J. Van Depoele, electrician of the Van Depoele Electric Light Company, Chicago:

This electrical railway is a notable and successful attempt to propel cars by electricity, and the great success achieved is really an important step toward the ultimate application of the power to this and other work.

The locomotive car, containing the electric motor and appliances, weighs about 7 tons, and occupies a space of 6×14 feet. The motor is of the type of the standard dynamos, manufactured by the Van Depoele Electric Light Company, Chicago, Ill., and the power available is about 30 H. P. The electric current is generated in the machinery hall building, where a steam engine is running a 40 H. P. generator of the same type as the motor. The current from said generator is conveyed by means of two copper conductors from the generator to two flat copper strips, running the whole length of the track, some 2,000 feet. These copper strips are carried in a base made of well-seasoned lumber, thoroughly permeated with insulating gums. The insulation leaves nothing to be desired. Upon these two strips two brushes are traveling with the car, carrying the current to the switches and motor. The whole arrangement is complete in every detail. The cars can be run back and forward with perfect ease, and fast or slow as desired. The track, as above stated, is some 2,000 feet in length, and has for a distance of 1,000 feet an incline of from $\frac{1}{8}$ to $\frac{3}{16}$ inch to the foot. There are also four curves. The track is straight and level at each end. At present the motor car pulls three cars each of three tons weight empty; each car can carry sixty people or more. With the power at command the number of passengers could be more than doubled. For experiment the train has often been stopped on the middle of the incline, but the moment the current was applied to the motor the train moved upward with wonderful rapidity, showing that the power is ample, and the scheme a perfect success.

The electrical railway has proved a great success, and there can be no doubt that electrical railways will, eventually, be permanently adopted in most places where street railways are now in use, as well as other short lines of street railways between cities. The Van Depoele Company have several patents upon this system of electrical railway, and upon motors for same, and are now making preparations to put in railways at several places in the United States.

THE B. & O. IN THE SOUTH.—The Nashville (Tenn.) *Tribune* says the Baltimore & Ohio Telegraph Company has requested the East Tennessee, Virginia & Georgia for the right of way for telegraph poles and lines between Chattanooga and Bristol, and the railroad agrees to give the right of way on the telegraph company paying reasonable rates, which will be fixed by a jury of five. The Baltimore & Ohio offices will open in Knoxville, Nashville, Chattanooga and Atlanta simultaneously.

ATTACHING TELEGRAPH LINES.—A dispatch from Buffalo, N. Y., of the 17th inst., says: The Sheriff to-day attached all the lines and other property of the Bankers & Merchants' Telegraph Company in Erie County. The attachment was served on behalf of John A. Roebling, Sons & Co., of New York, and was based on a judgment of $75,645.54, secured by Mr. Roebling in the New York courts. A similar attachment has been served in Batavia.

The Edison Light.

Speaking of the electric light, last Saturday, Mr. Edison said:

"I was looking yesterday at some plans for the proposed Grand Central Electric Station in Paris. It will supply 25,000 lights, and the wires will all be carried through the sewers. In New York we intend to build a station which will extend from Forty-fourth to Fifty-ninth street, and from Madison to Eighth avenue, about a square mile. It will supply 110,000 lights, 52,000 of which will be burning at once. The wires will all be carried under ground. Our down-town station has twenty-six miles of conductors under ground. This one will have 108 miles of street conductors, in iron tubes, laid under the pavement.

"In London what is known as the Electric Lighting act is so prohibitive that it is impossible to make any electrical progress there until it is modified. In Milan, Italy, there is a station with 10,000 lights. The theatres of 'La Scala' and 'Manzoni' are lighted with it, besides a smaller theatre and about a dozen of the principal hotels and coffee houses, notably the Cafe 'Biffi." I sent them a whole lot of conductors but a short time ago.

"We are lighting the Louisville Exposition with 5,400 of our lights, twice as many as you see here, and at the International Exhibition in New Orleans there will be 15,000 of them in one building that covers thirty-six acres—twice as much space as the Centennial buildings did. We can put the lamps in in sixty days."

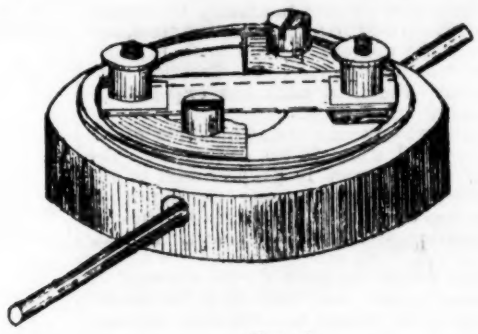


FIG. 3.

Overhead Wires in Philadelphia.

Considerable agitation has been caused in telegraph circles, says the Philadelphia *Record* of the 20th ult., by the manifested disposition on the part of many Councilmen to insist on an enforcement of the law requiring all wires to be under ground by January 1 on pain of removal. Superintendent Walker, of the Electrical Department, is prepared, he said, to cut every wire and pole in the city down if Councils instruct him to do so. He anticipates, however, a long litigation, with immunity for the telegraph companies in the meantime.

"So far," said Mr. Walker, "there has been really no satisfactory system of underground wires devised, the most of them being merely experiments. The Pennsylvania Railroad Company has asked me to recommend a system, but I could not do so. Councils, I think, will be lenient, and compromise by permitting the companies to keep up the overhead system until a thoroughly reliable underground one can be devised. They want to remove the unsightly poles as quickly as possible, but I hardly think any arbitrary action will be taken."

Exclusive of the city's own wires overhead, the various companies have 3,734 miles of wire on poles and housetops, and the total amount they now pay for all privileges is $22.537.95, the Bell Telephone Company, which is the largest customer, paying $4,985.50 yearly.

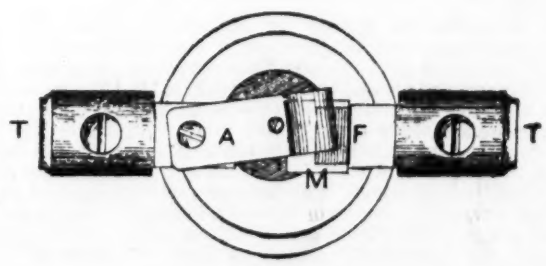


FIG. 4.

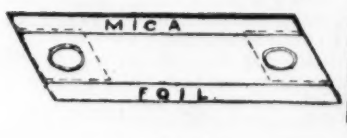


FIG. 3.A.

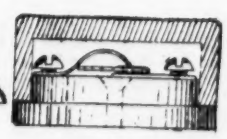


FIG. 5.

STUDYING ELECTRICITY AT RUTGERS.—The fall session of Rutgers College, New Brunswick, N. J., has begun. Electricity is likely to be studied there with more interest than ever. Among recent gifts to the college are $500 from Robert F. Ballantine, of New York, for the purchase of a dynamo machine for experimental uses, and $300 from Col. J. J., Janeway, of New Brunswick, N. J. to buy an engine to run the dynamo.

National Conference of Electricians.

(*Continued from page* 107.)

pose it increases very much, even for a considerable lengthening of the magnet.

As I said before, the magnetic conductivity of iron is many times greater than that of air, and we can lengthen out the cores without producing much loss on account of that lengthening. Some persons have suggested that there may be a slight gain from the fact that iron, after it has been magnetized a great number of times in the same direction, rather likes to be magnetized in that same direction afterward. If the core is made of any material similar to steel, such as wrought-iron or anything of that sort, it might be possible to have some gain from the coercive power of the magnet. There would be a loss from that cause; you have to act against the force of the magnet at first; but, from the continual use of the machine, I think very likely the iron might get a set in the direction of the force, which might possibly aid in the production of a suitable dynamo. If the core was of steel it is evident that you could send a strong current through at first, and magnetize the steel and then diminish the current slightly. We could thus still keep up a very large force at this point and with a moderately small current. I do not know how practical that would be, but, it seems to me, that one could produce a very strong field in that way. It may possibly be of practical value, and it might be tried. In the commencement of the operation of the machine, we would have to send a powerful current to magnetize the steel, and then, without stopping the current, to diminish it; then the force of the steel would be in the same direction with the current, and produce the field with less expenditure of energy than if it were simply iron.

As far as the difference between a shunt machine and a series machine is concerned, there is no difference. The magnetizing force of this magnet is proportional to the number of turns multiplied by the current; that is, proportional to the cross section of the coils multiplied by the current per unit of the section, so that the magnetizing action can be the same with a machine which produces a strong current and a machine which produces a weak current. If you calculate the energy, you will find it is the same, because it depends upon the current into the cross section. If the exterior dimensions of the coils are the same in both cases, the same energy is expended in each, in order to produce the same force, therefore there is no difference between a shunt machine and a series machine. I think the energy will be the same for both.

I do not wish to take up too much of your time, and I will go right on to the heating of the armature. Of course the amount of energy expended in the heating of the armature will be dependent on the resistance of the armature, and the efficiency of the circuit will merely depend upon the relation between the resistance of the armature and the exterior resistance; that is very well known. There is one other point: There is a certain lot of dead wire, you may call it—I do not know the technical term; I think very likely that that is the technical term. In the first place, I will only discuss the Gramme and Siemens arma-

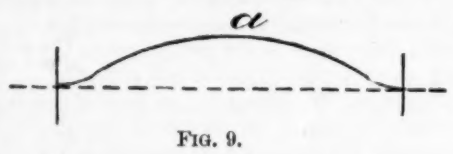


FIG. 9.

tures. In the Gramme machine you have the armature inside of the ring, and the ends do not act at all. In the Siemens armature, we have the coils brought over the ends of the armature. It is only a question of the work of the machines and the relation between the two. In the Gramme machine, it must be that less than one-half of the wire is acting.

You have the section of the Gramme ring like that (Fig. 10) and when that portion (*a*) of the wire is active, of course, this portion (*b*) is dead. I suppose some of the lines of force go out here (arrows) so that we can see at least half the wire is dead wire.

In the Siemens armature one cannot say immediately how much dead wire there will be, because it depends upon the length of the armature. In the Siemens armature you have the wire wound around in that way (Fig. 11), and this portion (*a*) would be active and this portion (*b*) dead. Of course, if the armature is very thick you would have more dead wire than when it is simply long. I cannot say which has the more dead wire, but I dare say the Gramme has more than the Siemens. Furthermore, either in the Gramme ring or the Siemens armature—I will draw this figure to represent either the Gramme or Siemens armature—you have the lines of force running (Fig. 12) across here (dotted lines); that portion is active, and this portion (*a*) in between the poles is dead; and when the thing revolves you have the lines of force turning around, and I think that would add more dead wire to your machines I believe an attempt has been made to throw out these dead coils; I believe in some form of machines they are thrown out. This is a practical point which everybody can understand, and if I should look over the exhibition carefully I would find some machine in which this is taken account of. There is no necessity to go further. Of course the efficiency of the circuit depends upon the ratio of the resistance of the armature to the resistance of the wires, and therefore, as far as this point is concerned, any machine can be just as efficient as you please by putting in greater and greater external resistance. But as the magnet remains the same, you would find a point where the efficiency of the machine as a whole would not increase for an increase of external resistance, and the work would actually diminish.

There are other things to be taken account of; there are some losses due to the self-induction of the coils which produce sparks in them. I have requested Prof. Fitzgerald to take up that point, and therefore I will leave it for him to consider.

Now I shall consider another point with regard to the dynamo which can be treated in this simple manner with no use of the calculus. I think it can be done by very simple reasoning, if you only know the principles. I shall now attempt to construct two machines similar in all respects, but one of which is larger than the other.

We can suppose that we construct one of the machines, and then see what the effect will be when that machine gradually grows and becomes very large.

The point we shall start from is that the magnetic field is constant in the two machines. Owing to the fact that there is a limit to the magnetization of a magnet, we cannot have a field which is produced by iron, with more than certain strength. Therefore, I suppose that you get up to a reasonable strength with your iron. It cannot be up to the maximum strength, of course, but it is somewhere near it. I made some experiments many years ago upon an ordinary magnet (and the results were published, I think, in *Siemens' Journal*). It is beautifully applied to the dynamo machines, and I obtained everything with it that I have referred to here. With that apparatus, if I remember rightly, I got about one-third of the force in the field of a magnet that iron could possibly give. Of course, you could get greater. It is theoretically possible to get a force equal to the magnetizability of the iron, or the maximum magnetism of the iron; but, practically, I suppose the case is very similar to that of the ordinary dynamo machine.

Therefore, we can say that the field of force in the two machines, one of which is larger than the other, shall be constant, and I will therefore write down F constant.

It is not only constant in one part of the machine, but in all parts; the magnetizing force at every point of one machine is equal to that in a similar point in the other machine. Therefore, if you drew the machines on the board, it would not make any matter about the scale of dimensions of the machine; you could mark down the force at a certain point as being a certain amount, and consider the scale whatever you please.

Starting from that point, we will consider what must be the current in the wire in the two machines. The machines have the same number of turns around the

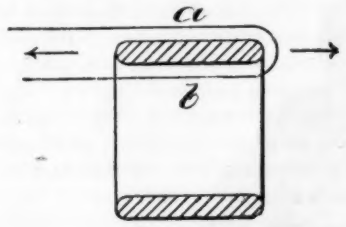


FIG. 10.

magnet, and everything is the same except the dimensions of one machine are greater than the dimensions of the other. I will give you a formula for the current in the wire. Suppose you have a tangent galvanometer. Consider the current passing around its coil. If you make the circular wire of the galvanometer grow, in order to produce the same effect at the centre you must add current in direct proportion to the radius of the coil. If you make that coil twice as large, you must have the current twice as large in order to produce the same force at the centre, and not only at the centre but at every point. If the material is constant, if there is no difference in the iron, we have the current in direct proportion to the linear dimensions of the figures, so that the current in the wire varies as the linear dimensions of the machine. Make one machine twice as large as the other, and the current per unit of area in the magnet must be twice as great to produce the proper motive force. Of course the wire has increased in size. If the machine is increased to twice its original size, the cross section of the wire is increased four times. In other words, from that cause the current per unit of area will vary inversely as the square of l the linear dimension; and since we have found the current to vary directly as l, in order to retain the same force in the field by a combination of the two results, it varies inversely as l. Therefore, as far as the magnets of a machine are concerned, if the machine grows larger in this way, its heating effect, which depends upon the current per unit of cross section, will be less, since the surface will have been increased in proportion to the square of l. There will therefore be less danger of heating in a large magnet than in a small magnet. This is only with respect to the magnet. In some cases it is practically found harder to run a large machine than a smaller one; but we shall find how that comes.

The resistance of any part of the machine and the work of the armature varies, of course, directly as the length of the wire and inversely as the cross section. The cross section varies as l square, so that the whole work varies inversely as l, or the resistance varies inversely as l. Therefore the larger you make the machine the less the resistance will be; one machine being twice as large as the other, the resistance will be half as great.

I will now consider the electromotive force. This applies not only to the work of the magnet but also to the work of the armature. We have here the current and the resistance. The electromotive force is proportional to the product of the current and the resistance, hence we may write $E = R\ C$. Therefore the electromotive force of this machine will be constant. We shall presently see how this is modified so as to get the electromotive force greater for the larger machine. The work done is there-

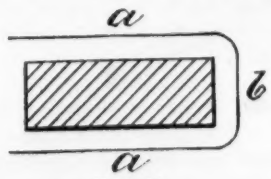


FIG. 11.

fore equal to $C^2\ R$ in any part of the machine, or in the whole machine just as you please. But that quantity varies directly as l, the linear dimension. Therefore the one machine, which is twice as large as the other, requires twice as much power to run it and you get twice as much electrical energy out of it. But it is to be remembered that the weight of the machine varies as l^3, and you have only got l times the work out of it as constructed in this way.

Let us see what the reason of this is. The field of the magnet is the same. There are just as many lines of force in the armature in the two machines, and when we calculate up, we shall see that the angular velocity of the armature or the number of turns per second or minute must vary inversely as l^2. In other words, in one machine twice as great as another, the velocity of the armature must be only one-fourth as great in order to produce the same current in the wires. This takes account, I think, of every irregularity in the machine—the two machines are exactly alike in every respect. I have not added the loss for the self-induction of the coil. I have an idea that this also should be taken into account, but Mr. Fitzgerald will consider that point.

So far as the results go, we have constructed two machines which differ only in size. The efficiency of these two machines is a constant quantity. That will be rather startling to some who come to me constantly and say "a larger machine is more efficient than a smaller one." As far as this thing goes, we have constructed a machine which is larger than another and in which the efficiency is the same.

Let us see the cause of the efficiency remaining constant. On what does the efficiency depend? We have got to keep our magnetic field the same in both cases; and therefore work done in sustaining the magnet will be this (C^2R). But here we have the angular velocity inversely as the square of the linear dimension. The question comes up again, whether we can not increase the velocity of the armature above that point. Is it practically necessary that we should run one machine at one-fourth of the velocity if it is twice as large? It is a practical question as to what we can get; I should think it certainly was not in this proportion; I should think it would be more nearly inversely as the square of the size. Can we not then run the machine with greater angular velocity? We certainly can do so by increasing the external resistance, so that the same current flows when you run it fast as in this case. Then the driving force will be the same, and the whole machine will be increased in efficiency. We can certainly do that to a certain extent; I do not know where it will end practically; but starting with a small machine without increasing the electromotive force which is constant in these machines, but by arranging the wire of the armature so as to increase the external resistance, we can increase the speed and yet have the current per unit of section through the armature the same as in this case. If we do that, we shall be able to increase the external resistance of the machine in comparison with the resistance of the armature, and when we do that we increase the efficiency of the machine.

I think it is from this cause that we find large machines more efficient than smaller ones. But it is also evident that there is a limit, which can only be obtained, I suppose, from practically making the machines, and seeing how fast they may be run without flying to pieces. If we can keep them going at a greater rate of speed than I have pointed out as they are increased in size, I suppose the efficiency will be increased.

As far as this theory goes, the increase comes not from the size of the machine but from the fact that you can get a greater electromotive force with the same angular velocity and so can increase the external resistance in proportion; so that you find in very large machines you can make the wire with one turn around the armature, not several turns—just have bars on the machines. We thus decrease the resistance of the machine and at the same time we run it above this relation which I have pointed out and so obtain the proper electromotive force. The proper electromotive force is more easily obtained from the large than the small machine, because it is not practically necessary to decrease the velocity. I will allow

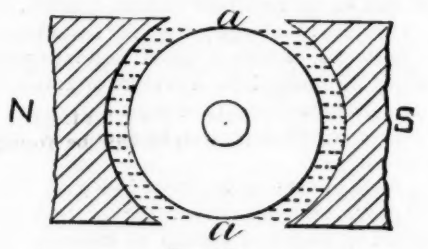


FIG. 12.

Prof. Fitzgerald to continue the discussion on the loss due to self-induction, and then the discussion will be open.

(TO BE CONTINUED.)

PERMISSION TO LAND A CABLE.—The difficulty between the United States and Dominion governments regarding the landing of a cable by the latter at Point Angelos, Wash., to connect with the British Columbia telegraph system at Victoria, has been settled, and the necessary permission obtained. The superintendent of Dominion telegraphs leaves on Monday for the Pacific coast to carry out the work. It will be remembered that the Dominion government refused similar permission to the United States Company some time since.

THE INTERCONTINENTAL COMPANY'S OPERATIONS.—The surplus receipts of the Intercontinental Telephone Company at Caracas and La Guayra in August were $1,637.27, and the company had 325 paying subscribers, and a cash surplus, Sept. 1, of $6,000. This will, it is expected, be increased to $12,000 by Jan. 1. With this it is proposed to build a similar plant to the above at Valencia and Porto Cabello, 80 miles from Caracas, and so situated as to call for a trunk line between the cities. The Caracas-La Guayra trunk line is very profitable. This complete, the company will have a plant of $40,000 in and between the afore-named cities. Net earnings are expected to begin flowing toward Boston early in 1885.

THE OVERLAND IN ROCHESTER, N. Y.—The certificate of incorporation of the Rochester Overland Telephone Company has been filed in the County Clerk's office. The objects of the company as stated are: The purpose of buying, constructing and owning, using, maintaining or owning interests in a line or lines of electric telegraph and electric telephone for a general telegraph and telephone business within the limits of the county of Monroe and beyond its limits if desired. Also for the purchase, use and sale of electrical inventions and the leasing the same, for the manufacture and sale of electrical instruments and supplies and for the acquiring and disposition of rights and franchises from and to individuals, cities, corporations, counties and towns, and to make, sell and buy patents, devices and machines for the application of electricity to the transmission of human speech, words, sounds, signs and messages. The general route of the lines of the company will be from Rochester through its streets and avenues to the surrounding towns and country. The capital is $250,000, divided into 25,000 shares of $10 each, and the company has the power to increase this amount if desired. The time of existence is to be fifty years. The names of the stockholders are Wm. V. Lockwood, Rochester, 8,334 shares; S. Gregor Doran, Rochester, 8,333 shares; Hiram McGonegal, Plainfield, N. J., 8,333 shares. The home office is to be in Rochester, and the above-named gentlemen are the trustees.

Exhibits at the International Electrical Exhibition—III.

We continue below our notices of the leading exhibits:

NEW YORK INSULATED WIRE AND VULCANITE COMPANY.

A large and interesting exhibit is made by the above company, of 13 Park Row, New York, of their various productions, and especially of the new insulating material, okonite. It is composed of rubber and various other ingredients, some of which have never been used before for this purpose. The compound was invented by Mr. J. J. C. Smith, an old and experienced manipulator and manufacturer of rubber, and it is to his knowledge and familiarity with chemistry as more particularly confined to the manufacture of rubber, that is to be attributed the successful result which has been obtained. The company claim that the insulation which they produce more nearly resembles the desired qualifications of an ideal insulated conductor than any other.

The wire is of a brilliant jet black color, has a smooth and polished surface, and is perfectly uniform in size. It is pliable and at the same time exceedingly tough and tenacious. It can be twisted in any conceivable manner even to the extent of breaking the copper wire in its centre, and the covering will be found to be still intact and without a crack upon its surface. The insulating compound is of a homogeneous nature. It presents when cut a grain similar to that of finely grained cedar wood, while its adhesiveness to the wire is very remarkable, requiring considerable force to detach it. By an ingenious process the wires are covered longitudinally, thus securing an unbroken line of insulating material with the wire always in the centre, a very important factor with insulating wires. Mr. Charles A. Cheever, the well-known president of the company, says that no wire of their manufacture is permitted to leave the establishment without being submitted to the most rigid tests, consisting in part of the submerging of each coil of 1,000 feet in a tank of water, 60° Fahr., for several days. It is then taken out and foot by foot its insulation, its specific resistance and its continuity of insulation are tested by a Thomson astatic mirror galvanometer to a point fifty per cent. above the resistance guaranteed by the company. The high resistance is proved also by showing the insulation to be entirely waterproof. A fact not generally known to the public is furnished by the manufacturers which is of general interest, *i. e.*, that rubber, either natural or vulcanized, is not entirely waterproof, the general opinion to the contrary notwithstanding. This can easily be demonstrated by soaking a piece of rubber in water for twenty-four hours, first having noticed its weight, and again by weighing it after the twenty-four hours submersion, when its weight will be found to have increased. The percentage of water absorbed by pure rubber is about three per cent.; in compounds of vulcanized rubber, about five per cent.

The company state that their covering material is an entirely new compound, in which rubber forms the basis, but with other material not before used and such new combinations as to make it positively proof against water, as also against the action of acids, either pure or diluted, or the corrosion of alkalies, upon which fact they justify their claim for improved durability.

As the substance is a vulcanized compound, it is clear that it will bear heat to 250° Fahr., and to that degree the compound remains intact. Coils frozen to far below zero have been suddenly subjected to the above degrees of heat without any noticeable effect, even after repeating this test several times. Among the larger users who have had experience with the wire may be mentioned, the Postal Telegraph Company, who have the wire in use in their underground conduits, at Washington, D. C.; inclosed in lead in cables at Chicago, Ill., and in overhead wires and cables at various other points. The Union Switch and Signal Company have expressed themselves as well pleased with the results of their use in their automatic railroad signal service. The company refer to several other prominent parties for indorsement of their product, and state they have no hesitation in subjecting their wires to any competitive test for any of the qualifications necessary to the most desirable insulated wire.

THE STANLEY AND THOMPSON INCANDESCENT ELECTRIC LAMP.

At the International Electrical Exhibition the extensive annex is mainly illuminated by what are hereafter to be called and known as the "Stanley and Thompson lamps," so called according to a legal agreement between the inventors, William Stanley, Jr., and Edward P. Thompson, executed at the time of the purchase of the patent by George Westinghouse, Jr., of Pittsburgh. In the circulars issued and widely distributed by the Union Switch and Signal Company, manufacturers of this lamp, the Stanley and Thompson lamp is described under another name. The inventions in this lamp comprise principally that of the method of manufacturing the carbon filament from a new chemical preparation, and the process of carbonizing several hundred horse-shoe-shaped carbon filaments simultaneously in the space of five or six cubic inches; while the advantages claimed refer to the high specific resistance and uniformity of structure of the carbon filaments, and simplicity and cheapness of manufacture. The dynamo machine of this system, it is maintained, possesses points of superiority which, in themselves, are sufficient to cause its general adoption. Dynamos are furnished of capacity to run fifty, one hundred, two hundred and four hundred lamps of sixteen candle-power; also, to run twenty and forty lamps of two hundred candle-power in series. They are simple in construction, having great strength and rigidity, and thorough ventilation is secured. The journals are of extra length, fitted with phosphor-bronze, and the wear can be readily taken up, while the construction of the armature in one piece insures it remaining in perfect balance, and obviates unnecessary wear and friction, with the attendant liability to get out of order. The commutator is perfectly sparkless, and may be freely oiled, which reduces the wear on this portion of the machine to a minimum. This dynamo is composed of a "Siemens consequent pole" field and a new armature so constructed as to be almost free from Foucault currents, while a new method of commutation renders the machine equal to any in the market as regards the range of electromotive force. The constant electromotive force machine is so constructed that a constant difference of potential is maintained at its terminals throughout the whole range of its capacity, not by the use of any auxiliary device, but by the peculiar construction of the generative apparatus. To provide for variations in the speed of the engine, a speed regulator is employed. By this system any number of the lamps may be cut out of the circuit without injury to the remainder. The company are now prepared to do business. Their display comprises electric motors as well. An ingenious arrangement of the lamps is shown by which when one goes out another is switched into circuit, and by which also a bell announcing the occurrence can be rung at any chosen place.

THE AMERICAN ELECTRICAL WORKS, PROVIDENCE, R. I.

This exhibit does not spread out over acres of space, but within its own modest limits there are contained in tasteful, compact array a great many interesting samples of the productions of the well-known Works, including electric light line and magnet wires; "Baxe," "silk" and "cotton" fine magnet wires; cables inclosed in lead, and anti-induction cables for use above and under ground; telephone cords and electric light cordage, patent rubber-covered wire, office and annunciator wires, and other electrical conductors. We would direct special attention to the display of bare copper wire, fine-drawn.

The American System of Electric Lighting.

We have received from the American Electric and Illuminating Company, of Boston, a copy of the second edition of their interesting pamphlet on the inception and growth of the company. The history it unfolds is one that ought to be familiar to every electrician as evidence of what can be done with a scientific system of electric lighting recommended to public patronage by business management in which prudence and enterprise are happily combined. Sometimes a bad lighting system may achieve partial success by dint of skillful pushing; sometimes a good system will fail utterly because it is not properly introduced. Rare indeed are the instances in which the genius that can invent good generators, regulators and lamps finds its ally in the genius that can properly build up on such a basis a great commercial and industrial institution. Having watched the growth of the American Company and examined their system in detail, we do not hesitate to say that our Boston friends present this rare felicitous union to notice, and enjoy all the conditions requisite to enduring success.

If some think that the statement is an exaggeration we would suggest that they read the pamphlet through or, if they prefer ocular demonstration of facts, that they take a walk at night through the streets of any city boasting the American light and supplement the walk by an inspection of the company's exhibit at the Philadelphia Exhibition, where the Thomson-Houston system is shown down to the smallest details of principle and construction.

Exhibition Notes.

The management of the Exhibition have had prepared by Prof. E. J. Houston a series of primers, which give briefly and clearly a vast amount of useful information on electricity and magnetism, theoretical and applied. The principal primers are: "Arc Lights," "Incandescent Lights," "Dynamo Electric Machines," "Voltaic Batteries," "Electric Circuits," "Effects of an Electric Current," "Magnetism," "Electro-Magnetism," "Electricity Produced by Friction" and "The Telephone." These little works give the information that the unlearned want as they look at the exhibits, and create a thirst for deeper draughts of electrical knowledge.

Since we noticed the exhibit of the Electrical Supply Company, a miniature electric light tower, beautifully made, has been put up in one corner. It is a model of the productions of the Star Iron Tower Co. Here in the East, the people are not so familiar with electric light towers as are the inhabitants of Western cities, and hence the tower is attracting much attention. The cables of the Callender Co. have now been arranged with admirable taste and skill, reflecting much credit on Mr. C. F. Suling, who has taken an active part in laying out one of the most handsome displays in the exhibition.

We have been glad to meet at the Exhibition Mr. W. H. Johnson, Manager of the Louisville Electrical Supply Company, Louisville, Ky. Mr. Johnson is an old-timer in the electrical business, and has had at Philadelphia to make many calls on his stock of reminiscences and anecdotes of early life.

If any one wishes to see how easily a sewing machine can be run by electricity, we suggest as a good example the operation of one of the machines of the Domestic Sewing Machine Company, of New York, to which is attached a Stockwell motor. Mr. E. A. Moon, who represents the company, takes pleasure in showing the ease with which the motor and machine work; and the perfect steadiness assists him in turning out some of the most beautiful and intricate sewing we have ever been invited to look at. It is amusing to stand near and listen to the ejaculatory admiration of the ladies who swarm around Mr. Moon, and beg for specimens of his fine work.

We learn from Mr. W. D. Marks, Superintendent of the Exhibition, that the little fire in a railroad car, mentioned in our last issue, did not occur on tracks within the Exhibition limits, although it was put out by the special corps of trained firemen employed by the Franklin Institute. The men had to climb the fence to reach the car.

Professor George Forbes, of London, lectured in the lecture-room on the evening of the 16th on "Dynamo-Electric Machines." His lecture was illustrated by experiments and by figures thrown upon a screen. The audience filled the large room, and showed its appreciation of Professor Forbes' efforts by frequent applause.

Producing Electricity Directly from Coal.

Mr. Edison claims to have succeeded in producing electricity directly from anthracite coal. He says he meant to have shown the process at the Electrical Exhibition were it not so extremely "nasty" and dangerous. If this can ever be accomplished with safety, he said, it would do away with engines and boilers in connection with the production of electricity, but it is as yet only a scientific experiment. Still, he obtained a very strong current in this way, though not without risk, since all the windows were blown out o his laboratory in the process.

The Keely Motor.

An exhibition has at last been made of the Keely motor, or, to speak perhaps more correctly, of the power to be employed for the motor whenever it shall make its appearance. This power Mr. Keely now promises to employ in telegraphy. The exhibition was given on the 20th at the Government range at Sandy Hook. A steamboat carried a brass band, bankers, brokers and scientific men to the number of 200. Mr. Keely, in his shirt sleeves, attended to the gun, surrounded by a number of officers appointed by the Secretary of War. A target was located 500 yards away. When the signal was given, Mr. Keely touched the valve. There was a slight report as the inch-and-a-quarter bullet left the gun, and then the visitors crowded about, wondering at the force that could pass so quickly through so small a tube as that connecting the gun with the vaporic reservoir. The gun was fired nineteen times, the last ball passing through one three-inch plank and half way through a second. There was no diminution in the force of the discharges, and it was claimed that over 100 shots could have been fired with the five gallons of mysterious energy stored up, and that the last shot would have just as much power as the first one. Mr. Keely said his force was made in what he called his generator, out of half a wineglass of water and a little air. After the firing, the tube was detached from the gun and the stop-cock turned slightly, so that the force could escape slowly, thus permitting the visitors to touch, taste and test it. On the boat's return, Mr. Keely made a brief speech, saying that he yielded to the pressure of Keely motor stockholders to test this gun publicly. In six weeks, he said, he would get his patents, and then the public should see this wonderful energy applied as a motive power. He explained the long wait of ten years as the natural consequence of working in a new field. Colonel Hamilton, the military expert, expressed great satisfaction with the experiments, and declared positively that the mysterious power used by Mr. Keely could not possibly be compressed air, carbonic acid gas, or any force known to the scientific world. He said that life is short, the motor secret precious, and that Mr. Keely should confide his secret to some one, so that in case of sudden death it would not be lost.

PHOTOGRAPHING A COAL MINE.—The first attempt ever made to photograph the interior of a coal mine has been successfully carried out at the Keebinoor colliery of the Philadelphia & Reading Company, at Shenandoah, under the direction of James Temple Brown, agent of the Smithsonian Institution. The slope is five hundred feet in depth, and the breast photographed is forty feet wide by sixty feet high. The photographer was G. M. Bertz, of Pottsville, Pa. The working was illuminated by the Arnoux electric light. Eight exposures were made, occupying from ten to thirty minutes each, and resulting in five perfect negatives, showing not only the formations of the coal measures, but also the practical operation of cutting coal and loading cars. The views are intended to constitute a portion of the United States Government exhibit at the coming New Orleans Exposition.

THE TELEGRAPH.

WIRE CUTTING JUSTIFIED.—John Kern, who was arrested some time ago on the charge of malicious mischief, preferred by the Baxter Overland Telegraph and Telephone Company, in Philadelphia, was acquitted last week before Judge Elcock. It was in evidence that the Baxter Company had stretched wires over the houses occupied by Kern and his neighbors without having secured permission to do so. He cut those over his own premises and also those over the premises of his neighbors at their request. In charging the jury the judge said the company had no right to place the wires over the premises without the consent of the occupants, and, having done so, the defendant was justified in cutting them.

THE TELEPHONE.

OUTPUT OF TELEPHONES.—The gross output of telephones by the New England Company in August was 245, and the net increase 100, making 18,765 sets of instruments in use Sept. 1.

NEW COMPANY FOR SANTO DOMINGO.—The Domingo Electric Company has been formed under the State laws of Connecticut, for the purpose of doing a general electrical business throughout the fast-growing Republic of Santo Domingo (the Eden of Grant's annexation dreams), under the absolute protection of a 50-year exclusive telephone concession recently granted to Preston C. Nason, of Boston. This company commences business by issuing one hundred thousand dollars of stock, in one hundred dollar shares, every dollar being taken and paid for at par, which is something extraordinary in these days of inflated corporations. It is intended to increase the capital of this company to one million dollars, in steps of $100,000, each as fast as the money is required to carry on other branches of their proposed work—this first hundred thousand going solely for local telephone plants. The syndicate controlling this company is a close one, and the members represent over ten millions. The Board of Directors are Lorenzo Blackstone, E. R. Thompson, C. C. Haskell, Preston C. Nason and W. R. Burnham. Officers: E. R. Thompson, President; C. C. Haskell, Vice; Preston C. Nason, General Manager; W. R. Burnham, Sec. and Treasurer. The General Manager's headquarters for the next month will be at the Astor House, New York, and our supply houses and inventors will find some notices headed "Telephone" and "Spot-Cash" in our advertising space, of special interest to them.

THE ELECTRIC LIGHT.

CHIHUAHUA, Mexico, is to have the electric light.

AKRON, O.—The Citizens' Electric Light Co., Akron, O., have taken two Cummer engines, 70 horse-power each, for their plant.

GOLD MEDALS.—At the exhibition lately held in San Francisco, the Thomson-Houston Electric Co. was awarded the first gold medal.

THE SUEZ CANAL.—A number of experiments with the electric light were recently made on the Suez Canal, and it is believed that vessels will be able to go through the canal at night, whereas navigation has hitherto been suspended on it between sunset and sunrise.

A NEWSPAPER OFFICE LIGHTED.—The Burlington, Vt., *Free Press*, a progressive paper, now has its entire building lighted by the Edison system, and supplies light also to some near neighbors. This is a new departure in journalism. At present the *Free Press* is the only Vermont paper to rise superior to the old methods of illumination.

THE BANNER COMPANY.—The Salt Lake Electric Light Company has increased the rate of its dividend to one per cent. a month, after paying a regular dividend almost from the start of eight per cent. per annum. This company was organized four years ago by Mr. C. C. Ruthrauff, of the Brush Company, and was about the first in the world to supply light from a central station. Under the efficient and able management of Major G. S. Erb, the president, a business of 160 lights has been built up. It is a remarkable fact that the entire plant is operated by four men—engineer, fireman, trimmer and superintendent. Salt Lake has 25,000 inhabitants, but only about 8,000 Gentiles, who alone patronize the light. The price charged for the light ranges from $13 to $15 a month. The capital stock is $50,000, fully paid.

MISCELLANEOUS NOTES.

A NEW ELECTRIC RAILWAY COMPANY.—The incorporators of the Bentley-Knight Electric Railway Company are Rowland R. Hazard, R. W. Blackwell, J. L. Blackwell, P. Chester, H. Stevenson, E. De Rune, F. B. De Calvo and W. B. Adriance. The company has a capital stock of $1,000,000 in shares of $100, and will build, sell and let locomotives and other rolling stock for railways in the United States and Canada.

RATHER HEAVY.—We have been hearing a good deal lately of a French balloon steerable against the wind with the aid of an electric motor. More information of a definite character on the subject is needed The electric motor that drove the balloon during the recent experiments at Meudon was no trifling affair to carry. It weighed 1,235 lbs., while the total weight of the whole balloon and accessories was only a little over 4,000 lbs.

STOCK QUOTATIONS.

Telegraph, telephone and electric light quotations are as follows on the New York Stock Exchange, the Boston Exchange and elsewhere:

TELEGRAPH.—Am. Cable, b 50, a 53; B. & M., b 5; Postal sixes, b 25, a 29; Postal Stock, b 3, a 3⅝; Western Union, b 62¼, a 62⅝.

Some $300,000 Bankers & Merchan's' telegraph bonds were sold in New York this week at 10@10¼, the stock at the same time bringing 5. It may or may not be significant that most of the bonds were purchased by a capitalist who is largely interested in the Western Union Company.

The Governing Committee of the Stock Exchange met on the 24th, for the first time since spring. A report was received from the committee to whom was referred the subject of how to prevent "bucket shops" from obtaining and profiting by the quotations of prices on the floor of the Exchange. This matter will be fully discussed at a special meeting of the Governing Committee. In the meantime notices are to be sent to the members of the Stock Exchange who are also members of the New York Petroleum Exchange and Stock Board, that under the rules of the Stock Exchange they cannot retain their memberships in both organizations. The Petroleum Exchange is now quoting the regular line of stocks, such as Western Union, etc.

TELEPHONE.—Am. Bell, b 158; Erie b 17, a 18; Mexican a 1 13-16; New England b 25, a 26.

All persons interested in the People's Telephone & Telegraph Company are directed by an order made by Judge Donohue, in the Supreme Court, to show cause before Albert H. Gleason, as Referee, on Nov. 15 next, why that corporation should not be dissolved, as the company has long been prevented from doing business by an injunction granted against it by the United States Circuit Court, and as it has transferred its property to the United States Telephone & Telegraph Company, a majority of its Directors wish it to be dissolved. It has no debts, and its assets are now only 3,000 shares of its unissued capital stock, and some books.

ELECTRIC LIGHT.—Edison, b 65, a 75.

BUSINESS NOTICES.

PROGRESS OF THE IDE ENGINE.—Mr. A. L. Ide is just finishing one of his 125 h. p. engines, which is used for driving 800 lights in the new Exposition building in St. Louis. Since January 1 he has placed his engines in the following electric light stations and buildings: Merchants' Electric Light and Power Co., Danville, Ill., 60 h. p.; Lasalle (Ill.) Electric Light Co., 50 h. p.; Mendota (Ill.) Electric Light Co., 50 h. p.; Lincoln Electric Light Co., Lincoln, Ill., 50 h. p.; Davis & Moore Co., Chicago, 60 h. p.; J. N. Raymond's Lead Works, Chicago, 60 h. p.; "Nee Baw" Japanese Bazaar, Chicago, 40 h. p.; National Life Building, Chicago, 40 h. p.; Sedalia Electric Light Co., Sedalia, Mo., 60 h. p.; Springfield Electric Light Co., Springfield, Mo., 60 h. p.; Guernsey Furniture Co., St. Louis, Mo., 40 h. p.; B. Nugent & Bro., St. Louis, 40 h. p.; Spaulding, Miller & Co., Montpelier, Ind., 60 h. p.; Ft. Wayne Electric Light Co., Ft. Wayne, Ind., 50 h. p. This is a very good showing indeed, both for the Ide engine and the electric light. In order to keep pace with the demand, Mr. Ide has now made arrangements with the Harrisburg Car Manufacturing Co., of Harrisburg, Pa., and C. L. Olds & Co., of Fort Wayne, Ind., for the manufacture and sale of his engine by them. All parts of the country can now be promptly served.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

Edited by N. S. KEITH, Electrical Engineer and Expert, 9 Murray Street, New York.

PATENTS DATED SEPT. 9, 1884.

Anti-Incrustator for Steam Boilers; S. G. Cabell, Washington, D. C..... 304,989
An electro-magnet within a boiler.

Circuit Closer for Burglar Alarms; Albert Iske, Lancaster, Pa..... 304,732
For attachment to window sashes.

Dry Pile; J. A. Thiebaut, Paris, France..... 304,764
Uses an agglomerated conducting-mixture composed of potash, gypsum and peroxide of manganese.

Electric-Arc Lamp; E. A. Sperry, Cortland, N. Y.. 304,966
A differential lamp with a new clutch device and short circuiting devices to insure continuity of circuit.

Electric Indicating Device for Elevators; C. L. Clarke, New York, N. Y..... 304,908
Indicates at desired places the position of an elevator car.

Electrical Meter; Chas. L. Clarke, New York, N.Y. 304,907
A galvanometer needle makes electric contacts in a circuit which causes the movement of registering mechanism to record variations in potential, or of current, or both.

Insulator for Lightning Rods; John Anthony Ruth, Baltimore, Md..... 305,020
Consists in the combination of an insulator composed of two interlocking sections, having a diameter hole passing through the interlocking parts, with the rod and the tie-wire bound to the interlocked sections and to the rod to firmly unite the parts.

Multiple Switch Board for Telephonic Exchanges; C. E. Scribner, Chicago, Ill..... 305,021
Consists in normally-open test circuits, one for each telephone line, and means for crossing or connecting any given telephone line with its test circuit while the telephone line is in use.

Non-Inductive Electric Cable; Mary E. Shaffer, New York, N. Y..... 304,759
Consists in weaving about the longitudinal wires of one or more circuits the wires of one or more independent circuits.

Production of Pipe Line and other Batteries; W. A. Shaw, Brooklyn, N. Y. 305,023
Consists in pressing out simultaneously two or more electrodes, with an intervening layer of electrolytic filling material.

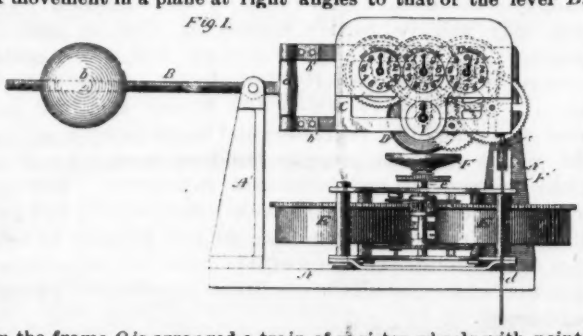
Self-Sustaining Electric Battery; W. A. Shaw, Brooklyn, N. Y..... 305,022
A copper plate is coated with carbon, and then with the zinc plate is covered by earth mixed with nitrates.

System of Electric Lighting; Edward Weston, Newark, N. J..... 304,882
Combines with two or more incandescence lamps in series devices in part automatic and in part manual, which are constructed and arranged to introduce to the circuit a resistance in place of, and equal to, each lamp cut out or extinguished, and cut out all resistances when the last lamp is extinguished.

System of Electric Lighting; Edward Weston, Newark, N. J..... 304,883
Provides for an entirely automatic operation of the system by which the derived circuits are cut out when all the lamps have been extinguished, whether by design or accident.

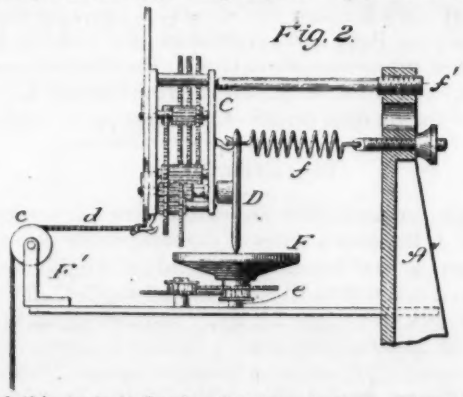
Electrical Meter; Edward Weston, Newark, N. J. 304,881
Referring to Fig. 1, A designates a baseplate; *A' A''*, and standards. To the standards *A'* is pivoted a lever, *B*, with a long arm, upon which is an adjustable weight *b*, and a short arm ending in a bar *a*, at right angles to the lever. *C* is a frame hinged by arms *b'* to the bar *b* in such a manner as to be capable of movement in a plane at right angles to that of the lever *B*.

Fig. 1.



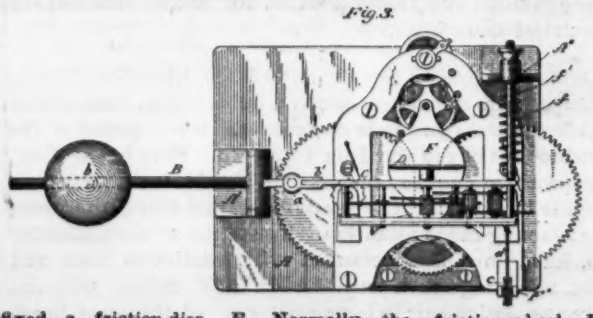
In the frame *C* is arranged a train of register wheels with pointers on the several spindles that turn in face of dial-plates graduated to indicate the revolutions of the said spindles, or the units of any scale corresponding thereto. Upon the main or first

Fig. 2.



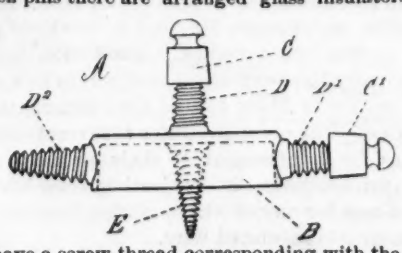
shaft of this train is fixed a friction-wheel *D*. Upon the plate *A* is set a motor, in this instance a clock-movement with two stout springs, *E E*, and ordinary reducing-gears that impart a slow movement to a spindle *e*. Upon the end of this spindle is

Fig. 3.



fixed a friction-disc *F*. Normally the friction-wheel *D* rests upon the centre of the disc *F*, the weight *b* being adjusted to produce the requisite pressure between the two. No motion will be imparted to the wheel *D* or the register therefor by the rotation of the disc *F* so long as they remain in these relative positions. If the frame *C* be shifted to one side, however, and the wheel *D* brought nearer the periphery of the disc *F*, it will receive a rotary movement which will be proportioned to the distance from the centre of the point on the disc upon which it bears. The frame *C* is connected to the standard *A''* by an adjustable spiral spring *f*. An adjustable stop *f'* extends from the standard *A''* in the path of frame *C*, and serves to limit the movement of said frame. A standard *F'* on the plate *A* or the frame of the clock-movement carries a grooved wheel *c*, over which passes a cord *d*, connected the one end to the frame *C*, the other to the movable part of the electro-magnetic regulating mechanism placed in a convenient position below.

Insulating Device; Geo. L. Broomhall, Paterson, N. J..... 304,699
A represents a device for covering the tops of telephone and telegraph poles of cylindrical form. The outer edge of the cylindrical top *a* is provided with a depending flange *B*, which flange is provided centrally with lateral projecting screw pins *D'* and *D²*, on which pins there are arranged glass insulators *C'*. The



insulators have a screw-thread corresponding with the thread on the pins, and are adapted to screw thereon. The cylindrical plate *a* is provided with holes *F*, and centrally with a vertical screw-pin *D* to accommodate an insulator *C*, the insulator *C* and pin *D* having corresponding threads, which adapt the insulator *C* to the pin *D*. The under side of the plate *a* is provided with a screw-pin *E*, which pin depends from the under side of the plate

System of Electric Lighting; Edward Weston, Newark, N. J..... 304,884
Consists of electro-magnets of high resistance included in circuits around the switches, and placed so as to operate on the cut-out armatures in opposition to the main magnets. The attractive force of these magnets, under normal conditions, is not sufficient to overcome that of the main magnets. Upon the separation of the contact-points of a switch, however, the amount of current diverted by the resistance of the arc causes the shunt-magnets to instantly draw down the cut-out armature, whereby a circuit equal in resistance to that through the lamp is established around the switch and the arc at once extinguished.

Telephone and Telegraph Switch-Board; E. W. Smith, Newark, N. J..... 305,025
Consists in the construction and arrangement of the several parts.

Voltaic Battery; Nicholas Basset, Paris, France.... 304,897
A depolarizing liquid consisting of Mo Cl Fe_2 Cl_3 in contact with the carbon, and an alkaline chloride in contact with the zinc.

Telephone Ear-Piece; Wm. R. Miller, Baltimore, Md..... 304,843
A cap fitting over the ear-piece of a receiver, and large enough to receive the ear of the listener.